



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

Preparing Communities for Nuclear Terrorism

D. L. Stewart

August 23, 2013

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Table of Contents

Table of Figures	iii
Acronyms	iv
1.0 Introduction	1
1.1 Community Resilience and Nuclear Terrorism	1
2.0 The Importance of State and Local Planning for Nuclear/Radiological Terrorism	3
2.2 Threat and Hazard Identification and Risk Assessments and Nuclear/Radiological Terrorism	4
2.2.1 How Funds have been used in the Past	5
2.2.2 Bringing the Issue of Nuclear Terrorism to Responders	6
3.0 Developing the Nuclear/Radiological Terrorism Section of the THIRA.....	7
3.1 Stakeholder Collaboration	7
3.2 Creating a Format and Scenario of an IND Detonation in Support of THIRA Steps 1 and 2	7
4.0 Supporting Information to Assist in Understanding Nuclear/Radiological Terrorism	9
4.1 Theft or Creation of a Nuclear Weapon.....	9
4.3 Sabotage of a Nuclear Site	10
4.4 Radiological Terrorism	10
4.5 State and Local Communities Need to Understand the Impacts of an IND Detonation	11
5.0 Planning and Preparedness.....	12
5.1 Prevention.....	12
5.1.1 The State of Maryland’s PRND Program	12
5.2 Response Planning	13
5.2.3 All Hazard Planning versus Specific Hazard Planning: How to Incorporate Nuclear/Radiological Terrorism.....	16
5.2.3.1 All Hazard Planning	16
5.2.3.2 Specific Hazard Planning	16
5.3 Response Planning Case Study: The State of California’s Radiological/Nuclear Emergency Response Plan	17
5.4 Recovery.....	17
6.0 Conclusion.....	19
7.0 Appendix A: Recent Survey Information Related to Nuclear/Radiological Terrorism Preparedness ...	22
8.0 Appendix B: Impacts of an IND Detonation	24

8.1 IND Detonation Types	24
8.2 Prompt Effects.....	24
8.4 Fallout Zones.....	26
8.5 Damage Zones.....	28
8.6 Injuries in Damage Zones	29
8.7 Impact on Emergency Responders	30
8.9 Impacts on Medical Community	31
9.0 Appendix C: Resiliency Considerations	33
9.1 Community Supply Chain Resilience.....	33
9.2 Increasing Resilience through Public Education	34
9.2.1 Fallout Education	34
9.2.2 Shelter Education	34
10.0 Appendix D: California Radiological/Nuclear Emergency Response Plan Case Study	37
10.2 Approach.....	38
10.3 Workshop Design	38
10.4 Workshop Findings/ Analytical Framework Summary.....	39
10.4.1 Communication/Messaging	39
10.4.2 Education and Training	39
10.4.3 Planning.....	40
10.4.5 Resources	40
10.5 CA Successes	40
10.7 Recommendations	41

Table of Figures

Figure 1: Five Elements of a THIRA, CPG 201.....	5
Figure 2: Red Cross- Aspects of disaster preparedness	14
Figure 3: Physical Effects of Overpressure, Atomicarchive.com	25
Figure 4: Damage Zones after a Nuclear Detonation: Idealized Maps, Planning Guidance for Response to a Nuclear Detonation, Second Edition, DHS, 2010	25
Figure 5: Fallout Zones, Planning Guidance for the Aftermath of a Nuclear Detonation, Second Edition, Interagency Policy Coordination Subcommittee for Preparedness & Response to Radiological and Nuclear Threats, 2010.....	27
Figure 6: Example of 12 different fallout patterns for Washington D.C. (IND Response Planning, LLNL)..	28
Figure 7: National Capital Region Key Response Planning Factors for the Aftermath of Nuclear Terrorism, LLNL.....	30
Figure 8: Boston Area Fire Stations colored by Dose Rate, HSIP Gold June, 2012.	31
Figure 9: Approximate acute death and acute symptoms estimates as a function of whole-body absorbed doses (for adults), LLNL.....	32
Figure 10: Nuclear Attack "Sheltering and Evacuation" Card prepared by Howard County Community Emergency Response Network	35
Figure 11: Shelter quality information that can be distributed to citizens, LLNL	36
Figure 12: Reference Sheet and Template for Workshop Group Discussion, <i>CCP 2013</i>	38

Acronyms

Cal EMA	California Emergency Management Agency
CBRNE	Chemical, Biological, Radiological, Nuclear, high yield Explosives
CCP	Center for Collaborative Policy
CDHP	California Department of Public Health
CPG 101	Comprehensive Planning Guide 101
CPG 201	Comprehensive Planning Guide 201
DHS	Department of Homeland Security
DNDO	Domestic Nuclear Detection Office
EMP	Electromagnetic Pulse
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
GAO	Government Accountability Office
HEU	Highly Enriched Uranium
IAEA	International Atomic Energy Agency
IED	Improvised Explosive Device
IND	Improvise Nuclear Device
Kt	Kiloton
LLNL	Lawrence Livermore National Laboratory
MEMA	Maryland Emergency Management Agency
Mrem	Milirem or one thousandth of a rem
NIMS	National Incident Management System
NPT	Nuclear Non-Proliferation Treaty
PRND	Preventative Radiological/Nuclear Detection
PSI	Pounds per-square inch
RDD	Radiological Dispersion Device
RED	Radiological Exposure Device.
Rem (R)	Measurement of radiation
RNERP	Radiological/Nuclear Emergency Response Plan
RNTRA	Radiological and Nuclear Terrorism Risk Assessment
SEMS	Standardized Emergency Management System
SFI	Strategic Foresight Initiative
THIRA	Threat and Hazard Identification and Risk Assessment
WIED	Waterborne Improvised Explosive Device

1.0 Introduction

Both Presidents George W. Bush and Barack Obama have designated the potential use of nuclear or radiological weapons by a terrorist organization as the most significant danger facing American society. In order to confront this threat the Obama Administration's 2011 National Strategy for Counterterrorism states, "We recognize that no nation, no matter how powerful, can prevent every threat from coming to fruition. That is why we are focused on building a culture of resilience able to prevent, respond to, or recover fully from any potential act of terror directed at the United States."¹ Promoting the necessary transition of a "culture of resilience" from ambitious rhetoric to plausible reality requires American communities to serve as the primary initiators. Rather than begin with a top down strategy at the national level, it is necessary to ingrain a whole of community approach at the local, state, and federal stages. Through utilization of resiliency planning techniques stakeholders can prepare for a wide spectrum of hazards ranging from natural disasters to the threat of nuclear terrorism. The National Strategy for Counterterrorism affirms that, "Supporting community leaders and influential local stakeholders as they develop solutions tailored to their own particular circumstances is a critical part of our whole-of-government approach that contributes to our counterterrorism goals." A catalyst for increasing community resilience is knowledge of the threat, what preparedness actions to take, how to implement those actions and communal consensus on why these actions are beneficial. It is important for community leaders to understand the risks associated with nuclear/radiological terrorism and the initial steps required to mitigate these dangers through resilience.

*"Today, the Cold War has disappeared but thousands of those weapons have not. In a strange turn of history, the threat of global nuclear war has gone down, but **the risk of a nuclear attack has gone up. Testing has continued. Black market trade in nuclear secrets and nuclear materials abound. The technology to build a bomb has spread. Terrorists are determined to buy, build or steal one.**"*

President Barack Obama

Prague, April 5, 2009

Community resilience is the capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of function and structure.

Community & Regional Resilience Initiative

1.1 Community Resilience and Nuclear Terrorism

The devastating impacts of an Improvised Nuclear Device (IND) will require the nation to be resilient in order to recover. The destruction inherent to a nuclear detonation seems incapacitating but the level of cultural determinism can dictate the potential for community resilience and recovery. Individuals who believe they can make a difference are more likely to survive disasters.² Western nations for example, are considered more likely to view catastrophes as phenomena that can be mitigated and prepared for; however, the bureaucratic nature of

government can hinder this view through competition. Moving from a competitive bureaucratic disposition to one of collaborative relationships can improve community resilience. These relationships as well as the deterministic view of catastrophe preparedness should be encouraged at every level of government.

Prevention, response, and recovery efforts will contribute to overall resiliency. These efforts will reduce the effects of a catastrophic event and will allow for critical infrastructure and key resources, economic activities, and other areas of society to bounce back accordingly.³ The process of building resilient communities represents a unique and often under emphasized opportunity for preventative counterterrorism entities and post event consequence mitigation planners to interact. A growing area of research promotes the strategy of “consequence prevention” in which traditional preventative bodies including law enforcement, security, and intelligence are viewed in line with strengthening resilience. Approaching counterterrorism from both a preventative and response standpoint may lead to safer and more prepared communities.⁴

Increasing public resilience to nuclear attacks is not a new realm of preparation. During the Cold War officials educated citizens on actions they could take to prepare for the use of nuclear weapons, such as participation in the U.S. Civil Defense Corps and the construction of fallout shelters.⁵ Today FEMA’s Citizen Corps operates in a similar fashion and assists citizens at the community level in anticipation of such disasters. Engaging populations in local, grass-root efforts of this nature will serve as a fortifying mechanism in building national resilience. Ideally, if both the community and officials “from the highest levels of national security community to the local fire chief are ready for catastrophic terrorism, not only will lives be saved during a catastrophic event, but the likelihood of that event happening is reduced.”⁶ For more information related to different types of community resilience including supply chain resiliency and resiliency through public education see Appendix C.

Another crucial element to building a resilient community is educating communities on how to respond to significant events. “The consequences of states’ reactions to terrorist attacks can far outweigh the effects of the attack themselves.”⁷ When considering reactions to terrorism, planners should keep in mind the theater in which terrorist organizations seek to operate. The fundamental element to terrorism is exactly that, “terror”, or widespread panic and fear.⁸ By teaching the community how to react to an attack while instilling a sense of trust in the preparedness system, communities will not only mitigate the consequences of the attack itself but also deny terrorists the fear they seek to instill in American citizens.

States should strive to avoid reactions to attacks that unwittingly further their adversaries’ agendas, a goal that may be aided by strengthening public resilience to terrorism- The Dark Matter of Terrorism.

Resiliency in the face of overwhelming emergencies will depend on the integration of several different actors at the local, state, and federal levels of both private and governmental organizations. Integrating these organizations on planning efforts can serve as a basis for their appropriate functions and cooperation during an actual event, the degree to which multiple stakeholders can operate efficiently together will dictate the confidence the public has in the preparedness system.⁹ When the public truly trusts the preparedness structure within their community, resilience will be possible.

Boston serves as the most recent example of this situation. The level of cooperation the Boston emergency response services received during and after the bombing of the Boston Marathon on April 16th, 2013 proved how resilient American communities have become since September Eleventh. The citywide shut down throughout the manhunt for the remaining suspect was truly emblematic of a resilient community. Not only did the community place trust in the emergency response system, they also aided law enforcement officials through their compliance, vigilance, and observation resulting in the rapid arrest of the second bombing suspect.

2.0 The Importance of State and Local Planning for Nuclear/Radiological Terrorism

Two brothers unaffiliated with a complex or well-funded terrorist organization carried out the Boston Marathon Bombing. The response by Boston authorities was very effective, due to the well-prepared police community. However, if the simplistic, easy to construct pressure bombs used by the brothers had included a small amount of radiological material to create an Radiological Dispersion Device (RDD), then the consequences of the attack would have likely been more severe even though the radiological material would not have significantly changed the hazards. Detection of radiation would have resulted in a delayed response that could have cost additional lives and recovery expenses. If the brothers had utilized an IND the effects would have been catastrophic. Embedding preparedness mechanisms from prevention to recovery for events of this nature could reduce consequences considerably.

The preparedness process is crucial to creating a resilient community as it offers the public an opportunity to think outside of the box. Critics will point to nuclear/radiological terrorism as a low probability high consequence event that as such deserves less attention. However, preparedness for a high consequence event like a nuclear detonation can prepare communities for an array of technically challenging emergencies. Simply thinking about the unknown allows a community to expand the intellectual process and develop a strategy that addresses a range of incidents including the low probability high consequence events.

Additionally, many state and local communities are beginning to recognize the importance of their role in addressing the challenge of nuclear terrorism, in both prevention and response areas. Figure 1 demonstrates the key elements of nuclear terrorism prevention and response. State and local capabilities, because of their large numbers and broadly distributed abilities, are well suited for detecting nuclear material as it moves within our borders.

National Preparedness: The actions taken to plan, organize, equip, train, and exercise to build and sustain the capabilities necessary to prevent, protect against, mitigate the effects of, respond to, and recover from those threats that pose the greatest risk to the security of the Nation- Department of Homeland Security. *National Preparedness Goal, First Edition, September 2011.*



Figure 1: Elements of Nuclear Terrorism Prevention and Response

If prevention efforts fail, it is the state and local response actions that have the greatest potential to save lives. The decisions made and actions taken in the first few minutes and hours after radiological or nuclear terrorism events are critical to response and recovery. The timing of these actions and the importance of understanding the community of interest, make state and local government preparedness critical.

A challenge to state and local communities in nuclear detonation response planning is the overwhelming nature of the event. Including nuclear explosions in the socialization of numerous threats like fires, earthquakes, and tornados is a beneficial way of developing all hazard preparedness without creating alarm when discussing a nuclear attack. Socializing all hazard preparedness at the community level will lead to overarching resilience throughout the nation. An important first step in initiating a culture of resilience is to conduct a Threat and Hazard Identification and Risk Assessment (THIRA) for a particular region, state, or jurisdiction. The THIRA process can serve many purposes including elicitation of federal funding, a baseline for hazard assessment and analysis, and a motivational tool for future planning.

2.2 Threat and Hazard Identification and Risk Assessments and Nuclear/Radiological Terrorism

Developing and maintaining an understanding of the variety of risks faced by communities and the Nation, and how this information can be used to build and sustain preparedness, are essential components of the National Preparedness System.

Department of Homeland Security, *National Preparedness System*, 2011

Conducting risk assessments through the THIRA process provides a common, consistent approach for identifying risks and associated impacts. The purpose of the THIRA is to enable the integration of threats into the risk assessment process. The THIRA mandates a whole of community approach in sharing information, identifying population factors, and understanding the cascading effects of a threat or hazard.¹⁰ Analysis of the THIRA results will guide future preparedness efforts across all mission areas. More importantly the analysis of the THIRA can be used as an educational tool for the community regarding potential risks as well as roles and responsibilities in the preparedness process. THIRAs are produced in alignment with the Comprehensive Planning Guide 201 (CPG 201) and consist of five elements:

Figure 2: Five Elements of a THIRA, CPG 201

1. **Identify the Threats and Hazards of Concern.** Based on past experience, forecasting, expert judgment, and available resources, identify a list of the threats and hazards of concern to the community.
2. **Give Threats and Hazards Context.** Using the list of threats and hazards, develop context that shows how those threats and hazards may affect the community.
3. **Examine the Core Capabilities Using the Threats and Hazards.** Using the threat and hazard context, identify impacts to the community through the lens of the core capabilities described in the Goal.
4. **Set Capability Targets.** Looking across the estimated impacts to the community, in the context of each core capability and coupled with a jurisdiction's desired outcomes, set capability targets.
5. **Apply the Results.** Plan for the ability to deliver the targeted level of capability with either community assets or through mutual aid, identify mitigation opportunities, and drive preparedness activities.

THIRAs can be completed either for the purpose of FEMA grant funding or in preparation for future grant funding as a way to identify the capability targets a community needs to support planning and resource allocation efforts.¹¹ THIRAs present an excellent opportunity for regional cooperation and if possible should be conducted cross-jurisdictionally with close neighbors who may also be affected by the consequences of a hazard.¹²

2.2.1 How Funds have been used in the Past

In continuing with the Boston example we see ways in which federal grant funding has been used to prepare for terrorism. Specifically funds were used to¹³:

Increase communications interoperability through the purchase of new portable radios and of new mobile radios for every first responder in the region; the development and maintenance of one of the first shared radio channel plans for public safety first responders (police, fire, and EMS) within the nine cities and towns in the region; the development and support of the Boston Area Ambulance Mutual Aid Radio Network which allowed communications between private ambulance companies and Boston EMS as they treated and transported approximately 282 victims to nearby hospitals; and the development and support of the Boston Area Police Emergency Radio Network which enables most first responders in the region to communicate with agencies from other jurisdictions and during the incident for operational and field communications across jurisdictions after the bombings and for the manhunt operations.

- **Facilitate intelligence and information sharing** by providing salaries for nine intelligence and GIS analysts and equipment (e.g., television screens, computers, surveillance, Sensitive Compartmented Information Facility) within the Boston Regional Intelligence Center (BRIC). These assets were critical in protecting and providing information to the first responders in the field. The analysts monitored, vetted, and triaged information concerning over 280 suspicious or criminal acts within Boston. In addition, they provided risk assessments on potential infrastructure targets, reviewed videos and social media for leads, and coordinated resources. For the presidential visit on Thursday, the analysts also provided pre-event threat assessments. After the capture of the bombing suspects, the BRIC tracked 42 potential and scheduled events, such as vigils and protests. In addition BRIC analysts were able to use the Digital Sandbox System, purchased with UASI funds, to build their risk assessment reports.

- **Provide critical infrastructure and key resources**, including 13 Explosive Ordnance Disposal (EOD) Detection K-9 Units from Boston, Revere, and Quincy which were deployed and assisted with identifying possible explosive devices and patrolling certain areas during the incident; EOD Personal Protective Equipment which the police departments used to protect their officers; EOD Equipment, including EOD robots which were used to search certain areas and respond to suspicious packages and EOD inspection cameras (night vision monoculars) which helped officers to see during the manhunt that began Thursday night; two Tactical Response Vehicles – Ballistic Engineered Armored Response Counter Attack (BearCat) vehicles – which the Boston Police Department used to protect their SWAT personnel as they patrolled streets, searching for the bombing suspects; and a CBRNE Mobile Command Vehicle which was used to transport Special Operations Division Tactical and Command personnel to the incident site and support on-scene intelligence sharing and investigations among first responders and transmit information to off-site locations. This vehicle was deployed for the marathon event and after the bombings was used for securing the incident site and then was moved to Watertown during the manhunt operations there.
- **Enhance planning and community preparedness** by providing a shelter trailer which was deployed to the family assistance center that served as a shelter; a Mass Notification System, ALERT Boston, which is the city's emergency notification system and which was used to send a message to the public informing them to shelter-in-place during the manhunt; Variable Message Sign Boards, which were posted at the marathon and in Watertown for the manhunt operations to inform the public of safety messages; and light towers, which were used at the crime scene for evidence collection during the night.

2.2.2 Bringing the Issue of Nuclear Terrorism to Responders

Although Federal planning is performed using detailed risks assessments, such as the Radiological and Nuclear Terrorism Risk Assessment (RNTRA), which evaluates the risk of millions of possible scenarios, these assessments are classified and not generally available for state and local planning which requires a more transparent process.

THIRAs offer a way to bring the threat of nuclear and radiological terrorism to the planning and response communities in an unclassified format. THIRAs can place the threat in context and improve understanding of a range of issues through a comprehensive overview of the hazard.

Including a feasible scenario in regional THIRAs may be a daunting task for regions not perceived to be at an inherent risk to terrorism. In order to do this the information must be available to communities so that they can include accurate, but unclassified, descriptions of the threat and consequences of nuclear/radiological terrorism. This includes guidance on specific scenario development. After a scenario has been formulated and the five aspects of the THIRA have been addressed in accordance to the CPG 201, communities should take the next step by developing prevention, response, and recovery plans. For information on recent surveys related to THIRAs and response plans for nuclear/radiological terrorism see Appendix A.

3.0 Developing the Nuclear/Radiological Terrorism Section of the THIRA

3.1 Stakeholder Collaboration

When conducting a THIRA and during successive planning efforts it is essential that a representative group of stakeholders is involved in the collaborative process. Including stakeholders within various levels of government as well as essential private sector individuals will provide a wide range of perspectives that can contribute to the risk assessments and plan development. Stakeholders from divergent areas of the community will offer insight that may otherwise remain unaccounted for when considering resources, vulnerabilities, capabilities, and know-how. According to the preparedness checklist created by the Center for Biosecurity of University of Pittsburgh Medical Center a “coalition of diverse stakeholders can help overcome the political and popular resistance to planning for an unthinkable incident like a nuclear detonation.”¹⁴

After the necessary stakeholders have been identified, a core-working group can be formed in order to oversee the THIRA development. The core-working group will begin performing a hazard assessment, which consists of identifying potential targets, obstructions, and vulnerabilities within the infrastructure. This initial phase will involve the identification of all potential hazards in order to form a list that incorporates known hazards as well as threats that have not been recognized before. For many regions this will include various human produced threats including cyber-attacks, active shootings, and conventional and nuclear terrorism. FEMA Region 10, for example has begun prioritizing these threats based on their level of consequence, focusing on events of high consequence as most important.¹ An IND detonation is of the most high consequence events and will require a substantial amount of planning that will allow for improvement in preparedness for several hazards. DHS can greatly assist the threat determination process by providing general, unclassified, nuclear and radiological threat information to planners.

The Importance of Including Local Perspectives

Local emergency managers should be included during this process, as they know better than those at the state level what exactly their community needs to confront particular threats. In a recent testimony by Mayor William Euille of Alexandria, Virginia, the mayor confirmed the value of federal grant funding assistance to overall community preparedness. Mayor Euille stated that the THIRA process must include the input of local elected officials and emergency response officials, and that FEMA must be able to audit states by comparing local risk assessments to the state level THIRA.

3.2 Creating a Format and Scenario of an IND Detonation in Support of THIRA Steps 1 and 2

Developing an IND scenario for the THIRA should include information regarding geography, city type (urban, rural, coastal, etc.) and population density. Port cities, for instance, may want to consider important infrastructure, landmarks, facilities, and tourist destinations located in or around ports and waterways. In a 2008 DHS report “Small Vessel Security Strategy” small vessels have been identified as a likely conveyance for transport of a WMD or radioactive material as well as a means of delivering a Waterborne Improvised Explosive Device (WBIEDs).¹⁵ Considering this mode of attack, potential points

¹ This information is based on a discussion with a FEMA Region 10 team leader for THIRA development.

of detonation such as docks, harbors, and waterways should be acknowledged as feasible when creating a scenario and throughout the planning process. Urban area planners not located near ports should similarly contemplate important governmental sites, events, tourist attractions, and symbolic points of interest within their region as potential blast locations for their scenarios.

FEMA's ready.gov website provides a list of generic potential targets that may help in identifying suitable locations for scenarios¹⁶:

- Strategic missile sites and military bases.
- Centers of government such as state capitals.
- Important transportation and communication centers.
- Manufacturing, industrial, technology, and financial centers.
- Petroleum refineries, electrical power plants, and chemical plants.
- Major ports and airfields.

The format of the nuclear detonation portion of the THIRA can be short and to the point like that of Oregon's THIRA or it can be more detailed like that of Michigan's in which both context and explanation of IND impacts are provided. The Oregon THIRA offers a region specific scenario with a description of a yearly, seasonal event as the theater for explosive attacks.¹⁷ Including a specific location and event in scenario development can be helpful later on in the planning process because events that are relatable can inspire a more personally invested understanding of what will be required from the response community. The Michigan THIRA includes a very generic stage for an IND detonation by only identifying likely locations (Grand Rapids, Ann Arbor, and Lansing).¹⁸ Where Michigan lacks in imaginative scenarios it makes up for in detailed explanation of the likely impacts of a nuclear detonation. Ideally, a THIRA would include a detailed scenario accompanied by a comprehensive assessment of the threat.

Both formats are beneficial to the overall goal of building more resilient communities but the more content that can be provided for a specific threat the easier it will be to elicit a comprehensive understanding of vulnerabilities and needed capabilities. FEMA's Strategic Foresight Initiative (SFI) promulgates the importance of scenario development in the planning process stating that, "By considering a broad range of alternative possibilities for the future, scenario planning helps account for the unpredictability of real life."¹⁹ Additionally, applying the appropriate context for an IND attack during scenario development is important because there are no national data records of previous attacks to inform the scenario. The mid-western states for instance, could easily incorporate data regarding tornados into their THIRA that statistically proves a need for increased capabilities in tornado preparedness. For an IND detonation, the contexts provided by those conducting the THIRA has to drive the perception that increased capabilities are necessary to address this threat because historical analysis is impossible. Existing scientific information on the impacts of an IND detonation to illustrate the potential destructivity of such an attack can assist in providing supplementary context and details. Collecting this information in the early stages of THIRA development will remain useful throughout subsequent stages such as prevention and response planning.

4.0 Supporting Information to Assist in Understanding Nuclear/Radiological Terrorism

Examining the nature of nuclear/radiological terrorism as well as the consequences will assist communities in fully understanding the threat it poses to their region. There are several possible scenarios to consider as part of a planning process.

4.1 Theft or Creation of a Nuclear Weapon

One scenario experts have identified is the theft of an existing nuclear device either from a current arsenal or formally belonging to a state arsenal.²⁰ The nuclear weapons stockpiles of the Former Soviet Union are consistently recognized as being at a particular risk to theft. Security and tracking systems for these weapons are considered relatively underdeveloped.²¹

Additionally, a hostile state, recognized as possessing nuclear weapons could transfer a device or multiple devices to a proxy group that could then use the device against the U.S.²² As early as 1987 the International Task Force on the Prevention of Nuclear Terrorism identified this scenario as a factor contributing to the possibility of nuclear terrorism.²³ This scenario is particularly dangerous, as a group with state assistance including funding, assets, and logistical support could pose a substantial nuclear threat to the U.S.

Scientists at LLNL conducted a study in 1964 confirming that the construction of a crude nuclear device by those with moderate skills and open source access is also possible.²⁴ Al-Qaeda has expressed interest in nuclear weapons and it is not unimaginable that a group of such vast sophistication and significant funding could acquire the skills and fissile material² necessary to build an IND.²⁵ In the pre-9/11 era alone the International Atomic Energy Agency (IAEA) reported 175 cases of nuclear trafficking^{3, 26}. Considering the amount of nuclear trafficking still persisting throughout the world it is presumable that a terrorist organization could gain the amount of material necessary to create a small-improvised device. A simple, crude, improvised nuclear fission weapon similar in design to the weapons used in Hiroshima or Nagasaki could have a yield of around 10kT.²⁷

The primary area of concern regarding INDs is their size. These devices are not likely to be the size of the 5 ton Little Boy nuclear bomb utilized during World War II, rather they may be small enough to be delivered as a truck bomb or possibly even in a backpack.²⁸

This form of terrorism has become of increasing concern as more countries either produce or seek to produce nuclear weapons and/or civilian nuclear capabilities. Due to the dual use nature of nuclear power even civilian nuclear countries are at risk for theft of nuclear material and spent nuclear fuel⁴.

² Fissile material consists of weapons usable uranium or plutonium.

³ Nuclear trafficking involves the illegal sale and smuggling of fissile material, weapons, designs and other affiliated items.

⁴ Spent nuclear fuel is fuel that has been irradiated (exposed to radiation) in a nuclear reactor.

4.3 Sabotage of a Nuclear Site

Another area of concern involves terrorists' use of explosives, conveyance, or other means to sabotage a nuclear facility for the purpose of causing a radioactive release in the community.²⁹ Nuclear sabotage can permanently damage a region and cause wide spread panic throughout the country. Given American standards of security in and around nuclear weapons complexes this form of nuclear terrorism has received less attention. However, more concern has been directed at this scenario after an elderly nun, construction worker, and "drifter" successfully snuck in to the Oakridge National Laboratory and vandalized its nuclear complex. Apprehension became wide spread throughout the U.S. and Congress posing the question, "What if they had been terrorists armed with weapons or explosives."³⁰ The actions of these three individuals alone have raised the concern for nuclear sabotage at U.S. facilities.

Attack on a spent-fuel storage pool by terrorists armed with explosives has also been identified as a possible path for creating a radioactive release in a community. Attackers may attempt to cause a breach in the pool wall, releasing thousands of tons of water and allowing the fuel to overheat.³¹

Another form of sabotage could involve an attack focused on a research reactor.³² Half of the research reactors in the world contain highly enriched uranium (HEU), which not only offers an attractive option for thieves but also as an attack location for terrorists seeking to cause a radioactive release.³³

4.4 Radiological Terrorism

Though radiological terrorism does not produce a nuclear explosion and does not involve the fission of atoms, it is included in the realm of nuclear terrorism because of the radioactive exposure potential from a device. Radiological terrorism can be conducted in three ways. The first is the combination of conventional explosives with radiological material such as Cesium (Cs-137), Cobalt (Co-60), Iridium (Ir-192), amongst other radioactive isotopes that are commonly found in medical facilities, research facilities, and industrial sites.³⁴ This material is prevalent in many countries including those with less stringent security measures that have experienced significant theft of such products. A terrorist group could acquire the necessary radioactive material either from abroad or within the U.S. and combine the material with an Improvised Explosive Device (IED) creating a "dirty bomb." These types of weapons are particularly concerning because their accessibility and simplistic design represent a very feasible attack mode.³⁵

According to the International Commission on Radiological Protection a second form of radiological release could simply include dispersing radioactive material via non-explosive means.³⁶

The final type of radiological terrorism is a Radiation Exposure Device (RED).³⁷ These devices involve an unshielded radioactive source being covertly placed in a crowded area in order to expose individuals to radiation and cause mass panic.³⁸ There is no explosion associated with an RED and the exposures can continue undetected for some time. Communities that utilize public transportation frequently may have a greater vulnerability to these devices. Enclosed areas with many people offer potential for significant exposure. Additionally, the congested nature of transportation facilities ensures anonymity for attackers in large crowds of strangers making an attack less obvious.³⁹

These scenarios may appear overwhelming but increasing understanding of each method of nuclear/radiological terrorism in communities across the nation will lead to the creation of preparedness systems capable of preventing and if needed responding to attacks of this nature.

4.5 State and Local Communities Need to Understand the Impacts of an IND Detonation

Understanding the impacts nuclear terrorism can have on a particular community is important to the planning process. The aftermath of an IND detonation will impact nearly every area of society (for a comprehensive explanation of the impacts associated with an IND detonation see Appendix B).

The publication of nuclear-test images supplemented by Cold War notions of colossal mushroom clouds has created false assumptions about how a low-yield nuclear detonation from an IND might appear.⁴⁰ The ability to distinguish a low yield nuclear detonation from a conventional explosion and ultimately enact response measures appropriate for an IND attack is mandatory for effective lifesaving operations.⁴¹

INDs have a considerably smaller nuclear yield⁵ than traditional nuclear weapons and if detonated in a metropolitan area the cloud shape generated from the blast will likely be chaotic in form as it interacts with tall structures and other impediments. Wind vectors will affect the direction and movement of the cloud potentially distributing it in several directions. Upper atmospheric winds possibly traveling at high speeds will increase the spread of the fall out cloud.⁴² Fortunately, with the right planning and preparation, many of the potential casualties from fallout can be avoided. Rapid response and prioritized actions can also help the response community save lives of those injured or trapped by the prompt effects.

As previous understandings of nuclear detonations are transformed to address the hazard of a low yield IND, local and state governments must identify the threat a nuclear terrorist attack poses to their jurisdiction and work to educate the emergency response community on the likely impacts. This will allow communities to develop response plans containing appropriate procedures and roles and responsibilities for the aftermath of nuclear terrorism that will assist the nation in improving its capacity for resilience as a whole.

⁵ Nuclear yield is the amount of energy discharged when a nuclear weapon is detonated usually expressed in TNT equivalent (10kt = 10 kilotons of TNT).

5.0 Planning and Preparedness

5.1 Prevention

Prevention includes those capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism.

National Preparedness Goal

Prevention planning is a crucial element in making communities resilient. Preventative measures can inhibit an attack from occurring and save hundreds of thousands of lives. Though we commonly think prevention is exclusively in the realm of the intelligence community several emergency services can play a role in preventing nuclear/radiological terrorism. Police, fire, security, and health services can all potentially be involved in the prevention of a nuclear or radiological weapon from being transported and detonated in the U.S. For example, police officers may be involved in detection, as they often possess radiation detection equipment and trained personnel. THIRAs are an excellent way to support increased prevention capabilities by identifying the need for community-based concept of operations, updated detection equipment, and training and exercises. Increasing prevention efforts will require the introduction of the threat of nuclear/radiological terrorism to emergency services in an unclassified manner like a THIRA as they may be the first to act in preventing an attack.

5.1.1 The State of Maryland's PRND Program⁴³

Preventative plans should be developed by local and state authorities to increase their capacity to inhibit nuclear/radiological terrorism from happening. The state of Maryland has been exemplary in prevention planning as they have embarked on a path to explicitly prevent radiological and nuclear terrorism through the development of the Preventative Radiological/Nuclear Detection (PRND) Program. The program is designed to deter, detect and report the hazardous handling and/or unauthorized attempts to import, possess, store, develop or transport illicit radiological/nuclear material within the state. Maryland worked with the DHS's Domestic Nuclear Detection Office (DNDO) with the primary objective of enhancing the radiological and nuclear terrorism prevention capacity in the state by maintaining a protection strategy, resourced with the capability to perform intelligence, threat and risk driven public safety interdiction, surveillance, and detection. The PRND program provides a regional mechanism for agencies and organizations within the State to share data and information about radiological threats and concerns.

In order to meet the goals of the PRND Program the assessment of current resources, equipment, staffing, and training throughout the State was required. The Maryland Emergency Management Agency (MEMA) agreed to coordinate a data collection effort to meet the needs of the statewide capabilities assessment. Surveys are an inexpensive, easily distributed option for conducting capability assessments across multiple jurisdictions. In the case of Maryland, MEMA collaborated with LLNL to produce the, "State of Maryland Rad/Nuc Detection Capability Survey," that was distributed to various local, state,

and federal departments (including fire, police, hazmat, and health departments) within each of Maryland's counties. The responses collected assisted the PRND program in developing a comprehensive database of all of the radiological/nuclear detection equipment that is currently possessed. This information will be used by the State of Maryland during the planning process to:

- Coordinate / inform users of equipment calibration and maintenance opportunities
- Identify surplus equipment that may be of interest to other agencies
- Enhance opportunities for lower cost bulk purchases and support contracts
- Share user experiences and identify existing local standard operating procedures and job aids for various equipment

The Maryland Concept of Operations identifies coordinating agencies and their functional roles within the PRND operational missions. The plan also specifies the steps required for an alarm response process and technical reach-back protocols, capability requirements and considerations, and suggestions on training and exercises. By including this information the CONOPS defines common terms to allow for consistent language across multiple agencies and jurisdictions. It also establishes a common alarm adjudication process and provides a Standard Operating Procedure to ensure consistency to individual agency's modification or PRND plans and procedures with those of the overall state strategy.

The document provides information related to early detection that identifies appropriate locations for radiation detection equipment and personnel. Interoperability methods are also included, which addresses the standardization of radiation detection devices, communication equipment, and training. Information is provided related to specialized technical support that uses a tiered protocol system to incorporate guidelines for the use of equipment, trained operators, and reach-back to subject matter experts who can differentiate between threat materials and authorized radiological material.

The Maryland PRND Program is one of many examples of State preparedness efforts that can be tailored to any community seeking to enhance their prevention program for nuclear and radiological terrorism. Conducting a survey of assets throughout the region is an ideal practice that allows emergency managers to evaluate their capabilities and give feedback to the state regarding areas in need of capacity building.

5.2 Response Planning

If a nuclear detonation were to occur on U.S. soil it is imperative that communities are prepared to respond to such an event. DHS has estimated that local and state communities will need to be capable of sustaining an immediate response until federal resources arrive. When identifying the consequences of an IND attack in a region's THIRA the information should be used to motivate increased response capabilities and response planning efforts. Solely increasing tangible capabilities like equipment updates will not be useful without a plan that describes how that equipment will be used and by which agency. Additionally, agencies will not know their roles and responsibilities without substantial plan development.

After it has been agreed that a response plan should be developed it is important to identify whether that plan will be designed to respond to a disaster or catastrophe. It is also necessary to determine whether the plan should be its own specific plan or an annex to a larger emergency operations plan.

5.2.1 Disasters

A Disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins."

International Federation of Red Cross and Red Crescent Societies, *Introduction to Disaster Preparedness*, June 2000.

Disaster preparedness involves strengthening communities and contributes to overall resiliency through education, support of local populations, and preparing local response efforts. Disaster preparedness includes⁴⁴:

- The development and regular testing of warning systems and plans for evacuation or other measures to be taken during a disaster alert period to minimize potential loss of life and physical damage.
- The education and training of officials and the population at risk.
- The training of first aid and emergency response teams.
- The establishment of emergency response policies, standards, organizational arrangements and operational plans to be followed after a disaster.

Figure 3: Red Cross- Aspects of disaster preparedness

1. Hazard, risk, and vulnerability assessment	2. Response mechanisms and strategies	3. Preparedness plans
4. Coordination	5. Information Management	6. Early warning systems
7. Resource mobilization	8. Public education, training, and rehearsals	9. Community-based disaster preparedness

5.2.2 Catastrophes

A catastrophe is any natural or manmade incident, including terrorism, which results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, and/or government functions.

Catastrophes are qualitatively more significant than disasters and therefore warrant different planning efforts in all aspects of planning including prevention, response, and recovery.⁴⁵ Dr. Quarantellie of Understanding Katrina lays out six criteria for recognizing a catastrophe, which will be important to consider when beginning the planning process.

These criteria include:⁴⁶

1. Most or all of the community built structure is heavily impacted. The facilities and operational bases of most emergency organizations are themselves usually affected.
2. Local officials are unable to undertake their usual work role, and this often extends into the recovery period.
3. Help from nearby communities may not be provided. In many catastrophes not only are all or most of the residents in a particular community affected, but often those in nearby localities are also impacted.
4. Most, if not all, of the everyday community functions are sharply and concurrently interrupted. Most places of work, recreation, worship and education such as schools totally shut down and the lifeline infrastructures are so badly disrupted that there will be stoppages or extensive shortages of electricity, water, mail, or phone services as well as other means of communication and transportation.
5. The mass media system socially constructs catastrophes even more than they do disasters. There will be longer national media coverage during a catastrophe.
6. Lastly, because of the previous five processes, the political arena becomes more important. National government and very top officials become directly involved and will be forced to effectively interact with lower levels of government.

When considering planning for a nuclear/radiological terrorist attack it is important to define the parameters early as to whether or not the process will treat the attack as a disaster or a catastrophe. A nuclear attack is not guaranteed to result in a catastrophe though it is very likely that it will. Whether an IND detonation results in a catastrophe is dependent on weapon size, detonation location, atmospheric conditions, population density, as well as the level of community preparedness and resiliency.

The use of a radioactive dispersal device is less likely to become a catastrophe, as the explosion will be far less severe. What may create a catastrophe is the public response to the radioactive fallout created by an RDD. These weapons of mass disruption could still result in several deaths, vast contamination, severe economic consequences, and a variety of other issues. Nuclear and radiological terrorism are typically combined in one category even though they will produce very different consequences. It is necessary to determine early in the planning process whether to treat radiological and nuclear terrorism as categorically similar enough to warrant joint planning or as separate threats that require two different plans. Ultimately, it will be beneficial to include both radiological and nuclear terrorism in any

form as either a disaster or catastrophe. It is better to start the planning process in some way and then expand upon the plan as capabilities, relationships, and vulnerabilities are identified.

5.2.3 All Hazard Planning versus Specific Hazard Planning: How to Incorporate Nuclear/Radiological Terrorism

5.2.3.1 All Hazard Planning

All Hazard Planning is typically conducted in an Emergency Operations Plan (EOP) at either the local or state level. This type of plan includes several different hazards and is often used as a foundation for other planning efforts and can serve as a centerpiece to which other plans can be attached. According to the FEMA's "Guide for All Hazard Operations Planning" a jurisdiction's emergency operations plan is a document that⁴⁷:

- Assigns responsibility to organizations and individuals for carrying out specific actions at projected times and places.
- Sets forth lines of authority and organizational relationships, and shows how all actions will be coordinated.
- Describes how people and property will be protected in emergencies and disasters.
- Identifies personnel, equipment, facilities, supplies, and other resources available—within the jurisdiction.
- Identifies steps to address mitigation concerns during response and recovery activities.

The EOP should be flexible enough to use in all emergencies and typically includes generic plans for mitigation, response, and recovery. A possible way of including the threat of nuclear/radiological terrorism in a jurisdictional plan is to develop an annex portion of the EOP. Cal EMA for instance, began integrating nuclear/radiological threats as an annex of their existing EOP. This annex is now serving as the basis for the development of detailed, specific plans for prevention, response, and recovery after a radiological/nuclear emergency.

5.2.3.2 Specific Hazard Planning

Specific hazard planning involves developing extensive plans for all areas of preparedness in as much detail as deemed necessary for the hazard. The impacts of an IND detonation will require a very specific plan. However, all hazard planning and specific hazard planning do not need to be mutually exclusive. There is no need to reinvent the wheel when initiating specific hazard planning for nuclear/radiological terrorism. Existing all hazard plans should be used to identify key roles and responsibilities already defined, prior communication structures that can be built upon, and capabilities that can be leveraged for specific planning purposes. When initiating the planning process for nuclear/radiological terrorism all existing plans should be examined in order to prevent redundancy. Most importantly, initiating an all hazard assessment will be the greatest driver in later developing specific hazard plans. Conducting a THIRA is an excellent way to begin the process.

The GAO found that the DHS places special emphasis on preparedness for terrorism in regards to grant funding that will be used to enhance first responder capabilities to prevent, protect against, respond to, and recover from terrorist attacks.⁴⁸ These grant funds can have all hazard applications. In the same way

that existing all hazard plans and grants can be applied to terrorism, future terrorism funding can be used to improve responder capabilities in several other areas.

The amount of time, effort, and collaboration needed to establish a resilient community and culture of preparedness should not be underestimated. Despite this daunting task of hazard assessment and plan development the reward for creating a prepared community, especially in the face of something as detrimental as an IND attack, will be immeasurable. The thousands of lives that will be spared if a community can become truly prepared for such potential devastation should be the inspiring force throughout this elaborate process.

5.3 Response Planning Case Study: The State of California's Radiological/Nuclear Emergency Response Plan

The California Emergency Management Agency (CAL EMA) has tasked the Center for Collaborative Policy at California State University Sacramento (CCP) in collaboration with the Lawrence Livermore National Laboratory (LLNL) to create an analytic framework that will serve as the foundation for the State of California's Radiological/Nuclear Emergency Response Plan (RNERP). The State of California has begun the process of completing a Statewide THIRA simultaneously with their plan development. Though in typical planning situations the THIRA would come before the plan, the analytic framework created by CCP could be used to inform the nuclear/radiological terrorism portion of the state THIRA.

The case study is detailed in Appendix D and provides a description of the project including scope and purpose, goals and objectives, working group formation, stakeholder workshop design, and workshop findings. The appendix also includes an assessment of the California project such as best practices and successes, barriers and challenges, and recommendations that can be utilized by emergency managers embarking on similar response planning paths.

5.4 Recovery

Recovery includes those capabilities necessary to assist communities affected by an incident in recovering effectively.

National Preparedness Goal

The final phase of the preparedness process is recovery. A community can truly become resilient if prepared from prevention through recovery. Recovery is an important element when building a culture of preparedness because it is the final phase before a community in post-catastrophe state transitions to a new status quo. Federal guidance has been created specifically for nuclear and radiological terrorism recovery planning, which should be reviewed by emergency managers initiating a planning effort. In 2012, DHS commissioned the document "Response and Recovery Knowledge Product: Key Planning Factors for Recovery from a Radiological Terrorism Incident," that can assist greatly during this process.⁴⁹ The purpose of this document is to allow the incorporation of key planning factors (pre-incident planning efforts initiated by state and local stakeholders) into state and local recovery plans.

According to the 2011 *National Preparedness Goal*, recovery requires timely restoration, strengthening, and revitalization of infrastructure; implementation of long-term housing solutions; a sustainable economy; and strengthening of the health, social, cultural, historic, and environmental fabric of communities affected by the incident. These will be difficult requirements to fulfill and will mandate additional planning. Recovery is a particularly important aspect of planning for a radiological/nuclear act of terrorism because “decontamination activities, heightened public anxiety, long term risk management, and substantial disruption to citizen’s lives and the economy,” prevent a typical recovery operation.⁵⁰ Developing recovery plans that specifically address these recovery issues inherent to a nuclear/radiological incident will assist greatly in the event of an actual attack.

Many assume that recovery begins after the response phase but it is actually conducted simultaneously with response efforts. DHS advises creating a realistic scenario to fully understand the damage that will be created by an IND or RDD in order to completely conceptualize the recovery needed in the designated area. The development of a scenario in a THIRA could serve as a basis for scenarios used across planning phases like recovery. By initiating the preparedness process through an assessment tool like a THIRA, planning can be developed for all phases of preparedness. Many aspects of the planning process will overlap and certain requirements can be used to guide each stage of planning. For example, “Develop Communication Plans” is a critical portion of plan development that will be necessary for all stages of planning.⁵¹ Other factors, however, may be specific to one stage of planning; for recovery one of these factors may be to establish background radiation levels before an incident, this can improve the determination of contamination levels in a given area. Other factors inherent to the recovery phase are developing pre-incident waste management guidelines and establishing radiation protection operational guidelines. As is the case with the other stages of the planning process recovery is essential to overall resilience.

6.0 Conclusion

The threat of nuclear/radiological terrorism is distinct from any other type of terrorism threat facing American society. Most research involving this threat is based on speculation as there has yet to be a case of this type of terrorism. This makes preparing for such devastation extremely difficult. Despite the inherent complications of preparing for a threat of this nature there are silver linings in initiating the communal thought process regarding nuclear/radiological terrorism. Including the threat in THIRAs provides a preliminary orientation of the threat with a multiplicity of other hazards. First responders, even without access to classified risk assessments can be introduced to the threat, likely impacts, and needed capabilities through its inclusion in a regional THIRA. This allows the threat to begin being socialized at multiple levels of government within a region. It is important to socialize issues like nuclear terrorism because, at first blush, the event seems overwhelming and unmanageable which can make starting the planning process difficult. Approaching the issue in an all hazard format like a THIRA introduces it along with several more manageable threats. The all hazards approach also allows for planning a capability development that is threat agnostic, for example mass evacuation is important to a variety of potential events, including earthquakes and nuclear attacks. As studies have shown in regards to community resilience, the challenge is making the community believe it can handle the consequences of events and that it can recover from any hazard regardless of severity. This is the underlying importance of including a detailed description of nuclear terrorism in THIRAs.

The THIRA is only one piece of the preparedness process but they offer an important cornerstone and impetus for subsequent activities. THIRAs provide an instrument to introduce a threat that will require substantial planning across multiple facets. The planning process includes substantial effort in the fields of prevention, response and recovery. Preparing a community is daunting, difficult, and in some ways controversial as it tests the relationships of every level of governance, however, the end product will be truly rewarding for any community willing to complete the process. States and communities that have confronted this challenge attain a tangible piece of resiliency. California and Maryland as well as several other states are pioneers in the nuclear terrorism preparedness world as they prove that despite consistent challenges in planning their communities are resilient and capable of preparing for any threat.

¹ Executive Office of the President. *National Strategy for Counterterrorism*, June 2011.

² Ripley, Amanda. *The Unthinkable: Who Survives when Disaster Strikes-and Why?* Random House, London, June 2008.

³ Jackson, Brian A. *Marrying Prevention and Resiliency: Balancing Approaches to an Uncertain Terrorist Threat*, RAND Corporation, 2008.

⁴ *Ibid*

⁵ *Ibid*

-
- ⁶ Department of Homeland Security, FEMA. *Managing the Emergency Consequences of Terrorist Incidents: Interim Planning Guide for State and Local Governments*, July 2002.
- ⁷ Boyd, Dallas, Souras, James. *The Dark Matter of Terrorism*, Studies in Conflict & Terrorism, 2010.
- ⁸ *Ibid*
- ⁹ Jackson, Brian A. *The Problem of Measuring Emergency Preparedness: The Need for Assessing "Response Reliability" as Part of Homeland Security Planning*, RAND Corporation, 2008.
- ¹⁰ Department of Homeland Security. *Threat and Hazard Identification and Risk Assessment Guide: Comprehensive Planning Guide 201 First Edition*, April 2012.
- ¹¹ Department of Homeland Security, FEMA. *Frequently Asked Questions: Threat and Hazard Identification and Risk Assessment*, 2012.
- ¹² *Supra*, citation 5.
- ¹³ The United States Conference of Mayors, Statement by William Euille. *Are we Prepared? Measuring the Impact of Preparedness Grants Since 9/11*, June 2013.
- ¹⁴ Center for Biosecurity of UPMC. *Rad Resilient City: A preparedness checklist to save lives after a nuclear detonation*, September 2011.
- ¹⁵ Department of Homeland Security. *Small Vessel Security Strategy*, April 2008.
- ¹⁶ Department of Homeland Security, FEMA. *Nuclear Blast*, URL: <http://www.ready.gov/nuclear-blast>
- ¹⁷ State of Oregon. *Threat and Hazards Identification and Risk Assessment (THIRA)*, 2012.
- ¹⁸ State of Michigan. *THIRA Analysis Draft*, August 2012.
- ¹⁹ Department of Homeland Security, FEMA. *Putting Foresight into Practice Highlights from the Strategic Foresight Initiative (SFI)*, May 2013.
- ²⁰ Allison, Graham. *Nuclear 9/11*, Bulletin of the Atomic Scientists, September 2006.
- ²¹ O'Neil, Andrew. *Terrorist use of weapons mass destruction: how serious is the threat?* Australian Journal of International Affairs, V.57 N. 1, 2003.
- ²² Perry, William J. *Preparing for the Next Attack*, Foreign Affairs V. 80 N. 6, November 2001.
- ²³ Gurr, Nadine, Cole, Benjamin. *The New Face of Terrorism: Threats from Weapons of Mass Destruction*, I. B Tauris & Co. Ltd., 2000.
- ²⁴ Jenkins, Brian Michael. *Will Terrorists Go Nuclear?* Prometheus Books, New York, 2008.
- ²⁵ *Supra*, citation 15
- ²⁶ Helfand, Ira. Forrow, Lachlan. Tiwari, Jaya. *Nuclear Terrorism*, British Medical Journal V. 324 N.7333, February 2002.
- ²⁷ Pavel, Nuclear Terrorism ***need source
- ²⁸ Maerli, Morten Bremer. Schaper, Annette. Barnaby, Frank. *The Characteristics of Nuclear Terrorist Weapons*, American Behavioral Scientist V. 46 N 727-744, February 2003.
- ²⁹ *Supra*, citation 19.
- ³⁰ Zak, Dan. *The Prophets of Oakridge*, Washington Post Special Report, URL: <http://www.washingtonpost.com/sf/style/2013/04/29/the-prophets-of-oak-ridge/>, 2013.
- ³¹ Garwin, Richard L. *A Nuclear Explosion in a City or an Attack on a Nuclear Reactor*, The Bridge V. 40 N. 2, Summer 2010.
- ³² Bunn, George. *Terrorism Potential for Research Reactors Compared with Power Reactors*, American Behavioral Scientist V. 46 N. 6, February 2003.
- ³³ Cameron, Gavin. *Nuclear Terrorism: Reactors & Radiological Attacks After 9/11*, in "WMD and Terrorism Second Edition," McGraw Hill, 2012.
- ³⁴ Department of Homeland Security, FEMA. *Radiological Dispersion Device*, URL: <http://www.ready.gov/radiological-dispersion-device-rdd>
- ³⁵ *Supra*, citation 25.
- ³⁶ International Commission on Radiological Protection. *ICRP Publication 96: Protecting People Against Radiation Exposure in the Event of a Radiological Attack*, 2005.
- ³⁷ Buddemeier, B.R., Trombino, D.G., Wood-Zika, A.R. *Radiological Terrorism: Assessment of Isotopes of Concern and Technology Options for Event Detection*, Lawrence Livermore National Laboratory, September 7, 2010. OUO.
- ³⁸ *Supra*, citation 17.

-
- ³⁹ Jenkins, Brian Michael. *Terrorism and the Security of Public Surface Transportation*, RAND Corporation, April 2004.
- ⁴⁰ Buddemeier, B.R., Dillion, M.B. *Key Response Planning Factors for the Aftermath of Nuclear Terrorism*, Lawrence Livermore National Laboratory, August 2009.
- ⁴¹ *Ibid*
- ⁴² *Ibid*
- ⁴³ State of Maryland. *Preventative Radiological and Nuclear Detection Concept of Operations*, 2013.
- ⁴⁴ *Ibid*
- ⁴⁵ Quarantelli, E. L. *Catastrophes are Different from disasters: Some Implications for Crisis Planning and Managing Drawn from Katrina*, Understanding Katrina, URL: <http://understandingkatrina.ssrc.org/Quarantelli/>, 2006.
- ⁴⁶ *Ibid*
- ⁴⁷ Federal Emergency Management Agency. *Guide for All-Hazard Emergency Operations Planning*, September 1996.
- ⁴⁸ Government Accountability Office. *DHS' Efforts to Enhance First Responders' All-Hazards Capabilities Continue to Evolve*, July 2005.
- ⁴⁹ Department of Homeland Security. *Response and Recovery Knowledge Product: Key Planning Factors for Recovery from a Radiological Terrorism Incident*, September 2012.
- ⁵⁰ *Supra*, citation 2.
- ⁵¹ *Supra*, citation 72.

7.0 Appendix A: Recent Survey Information Related to Nuclear/Radiological Terrorism Preparedness

In 2007, a House Committee Report to the 110th Congress entitled “Making Emergency Supplemental Appropriations for the Fiscal Ending September 30, 2007,” found that emergency management plans across the country are not up-to-date or systematic. Additionally, the conferees stated concern that communities were ill prepared to react in the critical moments shortly after a nuclear event.¹

Most cities still remain inadequately prepared for an IND detonation. The Government Accountability Office (GAO) recently conducted a survey in which questionnaires were distributed to 29 major cities asking (1) how their city assessed the risk of RDD and IND attacks, and the availability of local response plans for these attacks, (2) their perceptions of the city’s early response capabilities, and (3) their perceptions of the need for federal support to prepare for and respond to these attacks.²

22 of the 27 representatives who responded to the survey indicated that their city assessed risk using the THIRA approach and 14 of those identified an RDD attack, an IND attack, or both as a hazard to their cities. Only eight have completed some level of IND response planning and only two of that eight feel confident in their response plans. The cities that did express confidence in their response plans are those that have examined the potential impacts of an IND attack and consequently indicated the usefulness of response planning as a way to save lives and accelerate the recovery effort.

Only 4 city emergency managers considered their cities as having all of the needed response capabilities with mutual aid assistance for an IND attack. The majority of cities perceived their response capabilities as adequate in meeting the requirements of an RDD attack but not an IND attack. This is problematic because FEMA anticipates that local governments will need to be prepared for early response to both an RDD and IND attack with limited federal assistance during the first several hours of an event.

Emergency managers perceive a need for federal funding support to maintain and enhance their cities’ preparedness for RDD and IND attacks. A majority of cities suggested that any decrease in funding would adversely affect their early response capabilities, particularly training and equipment. Funding is crucial to the preparedness process and continually conducting and updating a jurisdictional THIRA could serve as a foundation for funding support.

Similar studies have been conducted corroborating the findings of the recent GAO study. The Council of State and Territorial Epidemiologists conducted a survey in 2010 that included assessments from epidemiologists in all 50 states to reassess the national status related to radiation emergency preparedness.³ The survey found that 70-84% of responding states had completed little to no planning for public health surveillance to assess health impacts of a radiation event and less than half of the responding states had written plans to address exposure assessment. In addition the lack of preparedness in the human health field, the recovery domain is also ill equipped for an IND or RDD attack. In 2009, the GAO conducted a survey in which city, state, and FEMA representatives were asked to assess their regions ability to recover from an RDD or IND detonation. Nearly all respondents

expressed concerns about the ability of federal agencies to provide the assistance needed to complete necessary analysis and cleanup activities required for recovery from an RDD or IND incident.⁴

The findings of these reports indicate the need to improve preparedness and confidence in preparedness plans throughout major U.S. cities. According to the 2013 GAO survey, the cities that valued response planning the most were those that studied the disastrous effects of an IND detonation. Additionally, the survey recognized the value of maintaining and updating regional THIRAs for the purpose of receiving federal grant funding to improve IND response capabilities.

8.0 Appendix B: Impacts of an IND Detonation

8.1 IND Detonation Types

Due to the fact that an IND is considered to be the most likely form of nuclear terrorism, it is important to consider the possible types of detonation⁵:

Air Burst: This is an explosion of a device detonated in the air where the fireball will not actually contact the earth's surface. Initial radiation effects will still be relevant but the fallout hazard will be less concentrated locally. This type of attack is more inherent to a traditional military fly over detonation than an act of nuclear terrorism but it should not be completely discounted.

Surface Burst: This is the detonation of a device at ground level where the fireball is touching the surface. An attack of this nature can also be conducted from the water aboard any type of sea craft. A surface burst is considered to be the most likely method of detonation by a terrorist group as it is designated in the National Planning Scenario 1.⁶

Subsurface Burst: This type of explosion occurs if a device is detonated underground or underwater. If the device is buried at a shallow point in the ground it will likely still perforate the surface but the thermal and blast impacts will be lessened. Fallout however will be very heavy locally. This is a possible mode of attack for a terrorist as burying the weapon may decrease detection of the device.

8.2 Prompt Effects

Flash of light: A brilliant flash of light will occur immediately following detonation. The flash will cause temporary "flash blindness" that can last for several minutes. Flash blindness can be experienced up to twelve miles away.

Prompt Radiation: Instantly emitted radiation across the electromagnetic spectrum primarily consisting of gamma radiation will emanate from the blast.

Thermal Pulse: Consists of thermal radiation that travels outward from the fireball created by the blast at the speed of light. It should be noted that the lower yield of an IND detonated in an urban environment diminishes the thermal pulse due to building shielding.

Electromagnetic Pulse (EMP): For surface bursts, the EMP can drive an electric current through underground wires causing local damage.

Overpressure: The pressure created by a shock wave well above normal atmospheric pressure. The chart below indicates the level of damage expected based on overpressure psi.

⁶ National Planning Scenario 1 involves the surface detonation of a 10kt IND in an urban area.

Figure 3: Physical Effects of Overpressure, Atomicarchive.com

Overpressure	Physical Effects
20 psi	Heavily built concrete buildings are severely damaged or demolished.
10 psi	Reinforced concrete buildings are severely damaged or demolished. Most people are killed.
5 psi	Most buildings collapse. Injuries are universal, fatalities are widespread.
3 psi	Residential structures collapse. Serious injuries are common, fatalities may occur.
1 psi	Window glass shatters Light injuries from fragments occur.

Damage Zones: The three damage zones created during a 10kt nuclear blast include the severe damage zone- immediately surrounding the detonation site, the moderate damage zone- extending 1 mile from ground zero, and the light damage zone- starting outside of the moderate zone and extending approximately 3 miles.

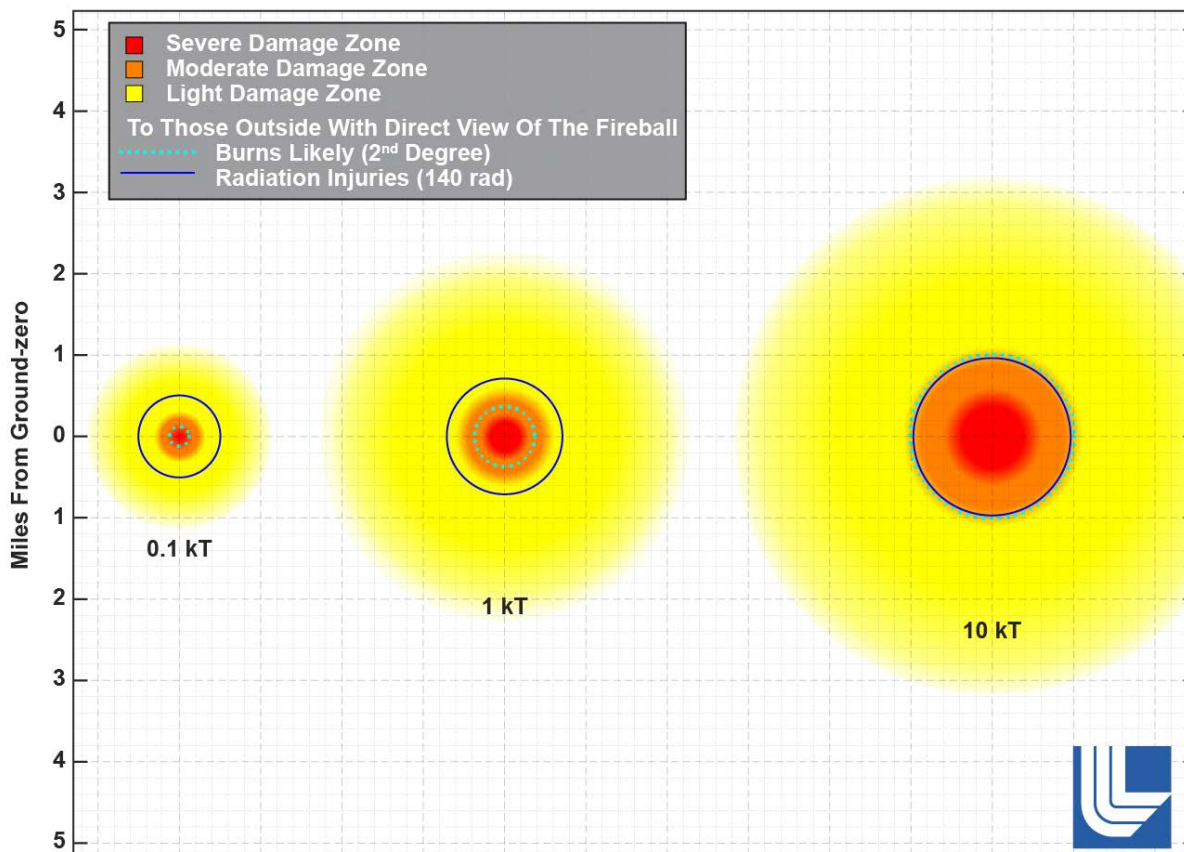


Figure 4: Damage Zones after a Nuclear Detonation: Idealized Maps, Planning Guidance for Response to a Nuclear Detonation, Second Edition, DHS, 2010

8.3 Delayed Effects

- **Cloud:** The blast cloud forms as everything inside of the fireball vaporizes and is carried upwards. Radioactive material from the nuclear device mixes with the vaporized material in the mushroom cloud.⁶
- **Fallout:** Fallout is created as the vaporized radioactive material in the blast cloud cools, condenses to form solid particles, and falls back to earth. The fallout can be carried long distances on wind currents as a plume and contaminate surfaces miles from the explosion.⁷

8.4 Fallout Zones

It is important to understand the radioactive zones created by the fallout. Expected radiation levels define these zones:⁸

- **Dangerous Fallout Zone:** The Dangerous Fallout Zone is classified by levels of radiation at 10 R/hr or greater. For a 10-kt detonation this zone may extend between 10 and 20 miles downwind from ground zero. Acute radiation injury is likely within this zone however; decay of radiation causes this zone to shrink after an hour.
- **Hot Zone:** The Hot Zone is characterized by a radiation dose rate of 10mR/hr (0.01 R/hr.) Acute radiation effects will not be experienced in this region but controls to mitigate any exposure will need to be considered. This zone may extend in any direction for 100's of miles but will shrink after about 12 to 24 hours as the radioactive particles from fallout decay.

The following image depicts the dangerous fallout zone progression outward from the blast. After around 12 hours the image illustrates how the zone will shrink as a result of radioactive decay. It is important to understand how fallout will act in a given area because it provides an indication of likely radiation dose exposures. Responders can use this information to inform the public of proper sheltering and evacuation strategies. Also, responders can utilize this information to determine when radiation exposure rates will be low enough to begin conducting lifesaving operations.

Fallout Zones

(Approximate for a 10kT)

Dangerous Fallout Zone (DFZ)

- Bounded by radiation levels of 10R/hr
- Acute Radiation Injury possible within the DFZ
- Could reach 10-20 miles downwind
- The decay of the radiation causes this zone to shrink after about 1 hour

Hot Zone

- Bounded by radiation levels of 0.01 R/h (10 mR/h)
- Acute radiation effects unlikely, however steps should be taken to control exposure
- For a 10 KT detonation, the Hot Zone could extend in a number of directions for 100s of miles
- The decay of the radiation causes this zone to shrink after about 12-24 hours
- After ~ 1 week the Hot Zone will be the size of the maximum extent of the DFZ (10-20 miles)

Blast Zones

(Approximate for a 10kT)

Severe Damage Zone (half-mile radius)

Most buildings destroyed, hazards and radiation initially prevents entry into the area; low survival likelihood.

Moderate Damage Zone (half- to 1-mile radius)

Significant building damage and rubble, downed utility poles, overturned automobiles, fires, and many serious injuries. Early medical assistance can significantly improve the number of survivors.

Light Damage Zone (1- to 3-mile radius)

Windows broken, mostly minor injuries that are highly survivable even without immediate medical care.

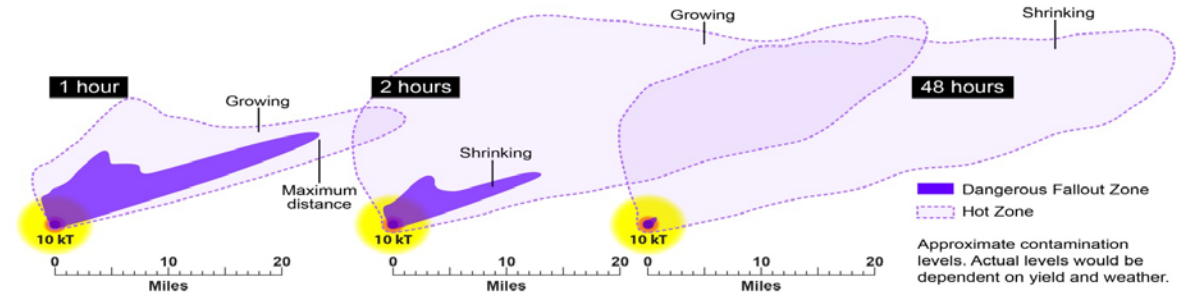
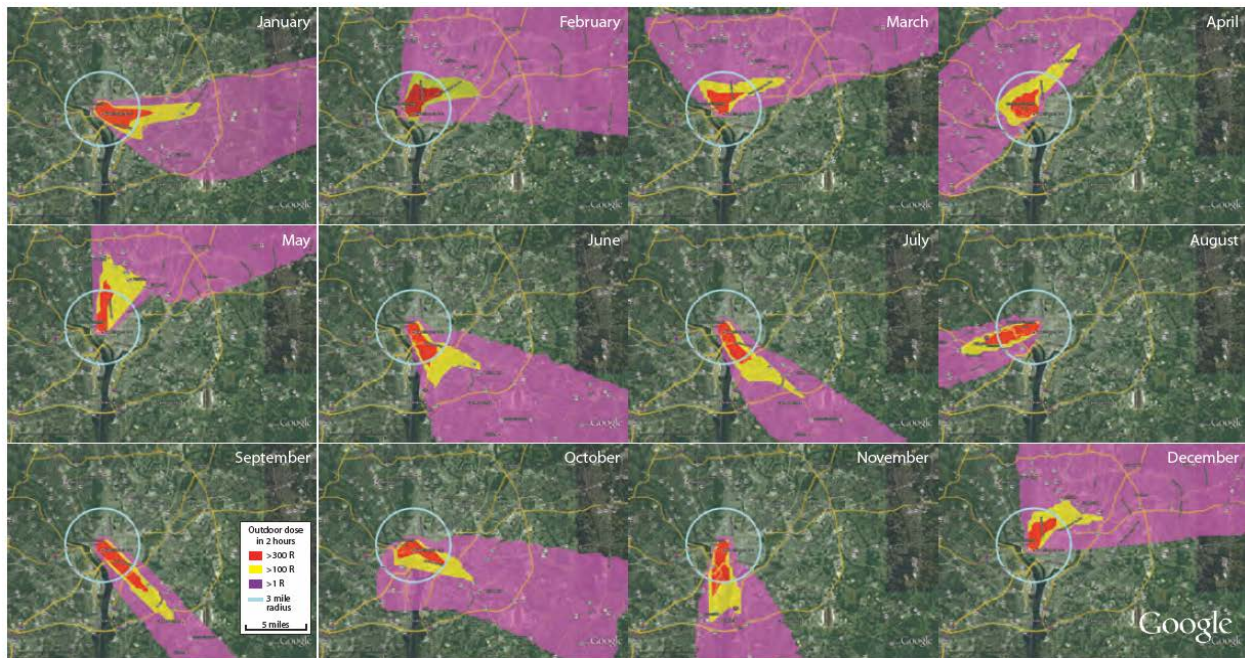


Figure 5: Fallout Zones, Planning Guidance for the Aftermath of a Nuclear Detonation, Second Edition, Interagency Policy Coordination Subcommittee for Preparedness & Response to Radiological and Nuclear Threats, 2010.

It is important to note that emergency planners should not plan for a specific fallout pattern, as the direction of the fallout cloud is variable and unpredictable. Planners should employ plume modeling as a tool to elicit roles and responsibilities that would be necessary in several situations. The following images illustrate how the fallout cloud may appear based on actual weather patterns in Washington D.C. The multitude of cloud shapes demonstrates that there is no universal plume that will emanate from a blast.

Figure 6: Example of 12 different fallout patterns for Washington D.C. (IND Response Planning, LLNL)



8.5 Damage Zones

Damage zones are important to discuss in greater detail so response planners may understand how the various zones produced by a blast are likely to appear within their region. This will allow planners and responders to distinguish what measures will need to be taken and to prevent further loss of life or injury to responders entering these zones. Additionally, understanding the capabilities needed to meet the needs of the damaged communities and infrastructure will allow those conducting a THIRA to better address their community's particular needs for this hazard.

An IND explosion will produce three levels of damage zones within the region of the detonation known as the "Blast Zone"⁹:

- Severe Damage Zone-** This zone surrounds the blast site and will likely kill any living organisms in the immediate area. Few buildings will remain intact and rubble piles in the streets will be impassable. Very high radiation levels and other hazards are expected and will likely make entering this zone immediately following an event impossible. For a 10-kt detonation, this zone would approximately extend 0.5 miles from ground zero. Infrastructure within this 0.5 mile radius will be substantially impacted and will likely damage water, power, and telecommunication conduits. Most underground damage from an IND will occur within the Severe Damage Zone.
- Moderate Damage Zone-** This damage zone extends approximately 1 mile from ground zero. Visual indicators will consist of structural building damage, impaired building interiors, fallen utility poles, destroyed and overturned automobiles, and fires. Visibility will be inhibited by dust and debris produced by the detonation. This zone will be contaminated by radioactive fallout and will produce sub-lethal levels of radiation poisoning in inhabitants. Piles of debris and rubble

will line the streets in the Moderate Damage Zone and will impede both evacuation and rescue missions.

- **Light Damage Zone-** Outside of the Moderate Damage Zone at about 3 miles for a 10-kt detonation a larger population than the other two zones will be affected. The destruction likely to occur within this zone is mostly due to the shock wave of the blast that can rebound off of buildings, terrain, and atmosphere. The shock wave will break windows throughout the zone and visual cues will consist of damage to window shutters, roofs, and lightly constructed buildings, rubble, and crashed automobiles. Injuries will mostly be caused by glass breakage as citizens go to their windows to investigate the flash or noise created by the blast.

8.6 Injuries in Damage Zones

It is of great importance for response planners to be aware of the wounds they will encounter after an IND detonation as injuries and damages may overwhelm medical response personnel.

- **Thermal Radiation:** The pulse of thermal radiation from the fireball produced by the blast carries thermal radiation energy that causes severe skin burns, eye injuries, and death.
- **Ionizing Radiation:** This causes radiation exposure that can be experienced at exposure rates of 100 rads and above with symptoms including vomiting, changes in blood count, cataracts, and cancer.
- **Non-radiation related injuries** - Blunt force trauma, punctures, and lacerations caused by flying debris, collapsed structures and broken glass. Perforated ears and collapsed lungs are likely injuries caused by the pressure of the blast.¹⁰

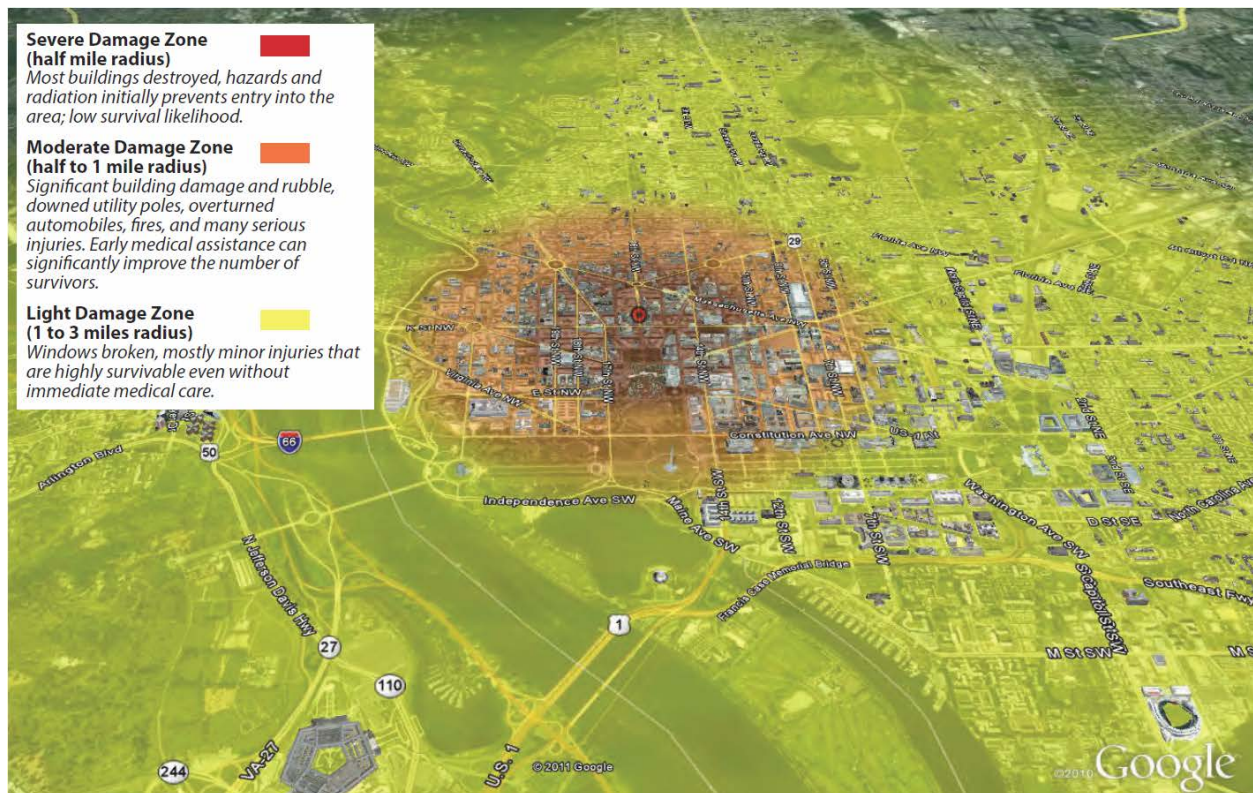


Figure 7: National Capital Region Key Response Planning Factors for the Aftermath of Nuclear Terrorism, LLNL

8.7 Impact on Emergency Responders

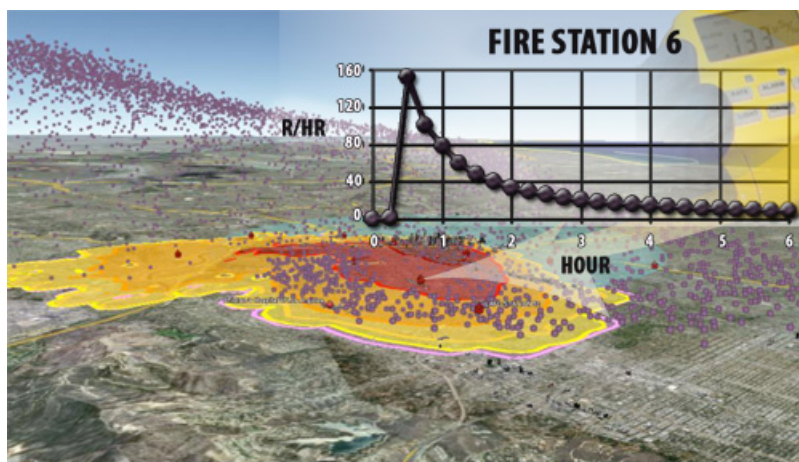
An IND attack will directly affect responders including firefighters, police officers, medics, and HazMat teams. Emergency workers will face several varying hazards in the aftermath of nuclear destruction including “ the usual hazards associated with building fires-flames, heat, combustion by-products, smoke-they also must be prepared to deal with rubble and debris, air choked with fine particles, human remains, hazardous materials (anhydrous ammonia, Freon, battery acids), and the potential risk of secondary devices.”¹¹ In addition to these traditional hazards responders themselves will be forced to confront radiation from the fallout. Assessments will be obligatory regarding the level of radiation in areas responders are attempting to operate. This will require the assistance of certified health physicists who can employ technology to determine the radiation risk of an area.

Sheltering in place is an important strategy for both the public and responders. Radioactive fallout decays quickly and individuals may decrease their integrated dose rate of radiation substantially by sheltering in place. The integrated dose rate is a measurement of radiation exposure over time, as radioactive fallout rapidly decays those sheltering can avoid being exposed to high levels of radiation immediately after the blast. This will seem counterintuitive to responders as their natural instinct will be to *respond* to the situation but if they rush outside while radiation levels are high they may be exposed to lethal levels of radiation causing them to become casualties as well.

The following figure illustrates how the responders can be impacted by a detonation in an urban setting. The image depicts a possible fallout cloud after a detonation in Los Angeles and what the dose rates might be at a local fire station over time. Note how rapidly radiation levels change during the event,

which is why planning efforts to ensure people are not outside during the most dangerous periods are critical.

Figure 8: LA Fire station 6 Does Rates.



Other considerations for responders¹²: It is a common misconception that a full body HazMat suit or other personal protection equipment is required to enter a contaminated area. Reducing the time spent in high-dose-rate areas is the greatest protective measure a responder can take, therefore search and rescue efforts as well as evacuation assistance, and lifesaving missions will require the fast entry and rapid exit of contaminated areas. The amount of time it takes to fully equip oneself with HazMat gear alone causes a delay, which could cost several lives. Once the suit is on the operator is restricted in movement and will be forced to spend more time in the contaminated environment full of gamma emitting radiation particles capable of penetrating the suit. Also, if that person should have to run or make sudden maneuvers they too could become a casualty in a hazardous environment. It should be considered that the ability to move quickly and spend less time in a radioactive area by avoiding HazMat suits might actually allow more lives to be saved.

Those entering radioactive areas for life saving operations should be trained how to assist those exposed to radiation. Evacuated survivors may be perceived as “contaminated” and a public health risk to receiving communities. Public safety officials will need to understand and explain the difference between persons who were exposed to radiation and those who may be contaminated by radioactive material.¹³ It should also be understood that survivor contamination by radioactive material is not considered a significant health risk to attending medical personnel or other responders.

8.9 Impacts on Medical Community

The medical and public health communities need to be prepared for the massive medical response that will be required after the explosion of an IND.¹⁴ The destruction of the blast may encompass hospitals, clinics, and personnel needed to respond to the event, straining the medical requirements of a disaster of this magnitude. Additionally, the potential for multiple attacks will spread available medical personnel even thinner. This indicates the importance of having a response plan in place that identifies multiple hospitals and assets that can be used for medical triage. Pre-event planning efforts will require the

training of medical professionals in the management of nuclear emergencies capable of providing prompt treatment for victims with acute radiation poisoning amongst other distinct injuries. Radiation exposure to victims will need to be assessed through “rapid automated biodosimetry”⁷ and clinical parameters and reentry, re-occupancy, and recovery issues will need to be considered by planners.”¹⁵

The information provided in Figure 9 (Approximate acute death and acute symptoms estimates as a function of whole-body absorbed doses for adults) is an example of information needed by medical response personnel in preparation for a nuclear detonation. Column three, titled “Acute Death from Radiation with Medical Treatment,” illustrates the ability of medical care to inhibit deaths related to varied levels of radiation exposure. Teaching medical and health officials that they can make a substantial difference in the number of survivors after radiation exposure will be important for increasing resiliency and cultural determinism within the health services field.

Figure 9: Approximate acute death and acute symptoms estimates as a function of whole-body absorbed doses (for adults), LLNL.

Short-Term Whole-Body Dose [rad (Gy)]	Acute Death^b from Radiation Without Medical Treatment (%)	Acute Death from Radiation with Medical Treatment (%)	Acute Symptoms (nausea and vomiting within 4 h) (%)
1 (0.01)	0	0	0
10 (0.1)	0	0	0
50 (0.5)	0	0	0
100 (1)	<5	0	5 – 30
150 (1.5)	<5	<5	40
200 (2)	5	<5	60
300 (3)	30 – 50	15 – 30	75
600 (6)	95 – 100	50	100
1,000 (10)	100	>90	100

^aShort-term refers to the radiation exposure during the initial response to the incident. The acute effects listed are likely to be reduced by about one-half if radiation exposure occurs over weeks.

^bAcute deaths are likely to occur from 30 to 180 d after exposure and few if any after that time. Estimates are for healthy adults. Individuals with other injuries, and children, will be at greater risk.

⁷ Biodosimetry is the use of physiological, chemical or biological markers of exposure of human tissues to ionizing radiation for the purpose of reconstructing doses to individuals or populations, *U.S. Department of Health & Human Services*.

9.0 Appendix C: Resiliency Considerations

9.1 Community Supply Chain Resilience¹⁶

According to the Strategic Playbook by Philip J. Palin of the Center for Homeland Defense and Security at the Naval Postgraduate School, making supply chains resilient can mitigate the effects of a catastrophe and prevent a disaster from transforming into a catastrophe. In order to accomplish this level of resiliency a deep comprehension of the relationships involved at every input of raw material to all aspects of consumption is imperative. Making these relationships resilient is defined by the ability to share information between members of the supply chain and understand each member's role. Modern supply chains heavily rely on digital information regarding nearly every facet from production to delivery. An IND detonation would likely render the digital infrastructure of a region unusable and dramatically impact the functionality of the regional supply chain.

Without a resilient supply chain, human necessities such as water, food, and pharmaceuticals cannot be distributed to the damaged region. Communities must establish plans that will allow for the continuation of supply chain distribution during the aftermath of a nuclear terrorist attack, which is a prominent benefit of including neighboring communities during the hazard assessment and planning processes. When considering the development of the nuclear terrorism portion of the THIRA and during response plan development, the creators should remember to include supply chain considerations such as:

- **Water:** A surface detonation will damage water mains. Also, radioactive material may contaminate city water sources. Treatment systems may be affected if a loss of electricity is experienced.
- **Food:** Distribution capabilities will be overwhelmed as personnel and delivery routes are impacted by the attack. Farms, grocery stores, and restaurants may all be damaged and unable to assist in supplying food for the public.
- **Pharmaceutical and Medical Goods:** Medical supplies will have to be delivered from adjacent communities to support the potential loss of hospitals and medical personnel and/or supplement medical triage efforts.
- **Alternate Power Generation:** Many critical infrastructure and key resources will be affected or destroyed by an IND detonation and power will need to be generated from other sources.

Addressing the supply chain during planning will allow stakeholders to identify existing issues in the current chain, determine which areas will require government assistance, and discuss the relocation of resources. The Strategic Playbook suggests asking questions like "What are your core capacities? How are you, your community, and your region supplied with water, food, pharmaceuticals and medical goods, medical care, and shelter? How are waste and other dangerous substances treated and removed?" These questions are inherent to THIRAs and initial planning efforts and answering them effectively will prevent confusion after an event and contribute to a faster recovery and overall resiliency.

9.2 Increasing Resilience through Public Education

9.2.1 Fallout Education

Incorporation of a fallout preparedness program within the wider planning scheme for nuclear/radiological terrorism is essential to citizen survival. Educating citizens will require a framework appropriate for that community regarding the best course of action to minimize fallout exposure and to save lives.¹⁷ Several federal guidance documents have been written to prepare communities for radiological hazards but very few communities have taken steps to educate the public about the threat. Pre-incident education that utilizes average citizens in the community as promoters of fallout preparedness may serve as a valuable tool in educating the public. When developing a community education element to preparedness plans it is important to deliver the message as a useful preparedness tip in order to avoid inciting any notion that there has been a real threat to the community.

One method of preventing the accidental incitement of fear is to conduct the message along with preparedness instructions for

An informed public is the best advocate for building required capabilities and creating a secure and resilient community.

several different hazards such as earthquakes, fires, and tornados. The collaborations essential for nuclear terrorism readiness can have spillover effects for other complex disaster management matters. Including a variety of potential threats in community education will not only prepare citizens for all threats but will also prevent nuclear terrorism from appearing as an isolated threat that may cause unnecessary panic or criticism.¹⁸

Fallout education should explain that avoiding outdoor exposure is the best option for preventing exposure to fallout. If a person is outside and is running towards shelter simply pulling one's shirt over their mouth as they run can mitigate ingestion of fallout particles. Before entering the shelter they should first remove contaminated clothing and wipe or wash exposed skin and hair. Many will be fearful of touching the particles but letting the fallout remain on the clothing will only increase exposure. Individuals should brush the fallout off of them rather than wait for thorough decontamination.¹⁹

9.2.2 Shelter Education

A sheltering strategy should be communicated to both responders and the population well ahead of an actual attack. Sheltering is an important facet of the response to a nuclear detonation. The characteristics of good, adequate, and poor sheltering locations should also be distributed to the community:²⁰

Quickly obtain adequate shelter; control contamination; perform a delayed, deliberate evacuation.

- *Good shelter:* Large concrete, brick, or underground structures like parking garages, multi-story office buildings
- *Adequate shelter:* Basements, tunnels, subways, shopping malls, schools

- *Poor shelter:* Vehicles, rail systems, mobile homes, single story wood frame houses, single story commercial structures without basements.

Federal guidance suggests staying in doors for 12 to 24 hours after the detonation to allow the level of radiation in the area to decrease. If not impacted by fires or structural damage the population should remain sheltered until emergency services notify the community that it is safe to evacuate. Figure 8 below is an example of a public information card advising the citizens of Howard County of the community sheltering strategy. Figure 11 provides an overview of the safest emergency sheltering locations inside different types of buildings.

Figure 10: Nuclear Attack "Sheltering and Evacuation" Card prepared by Howard County Community Emergency Response Network



If a nuclear attack occurs, knowing the information on this card could save your life

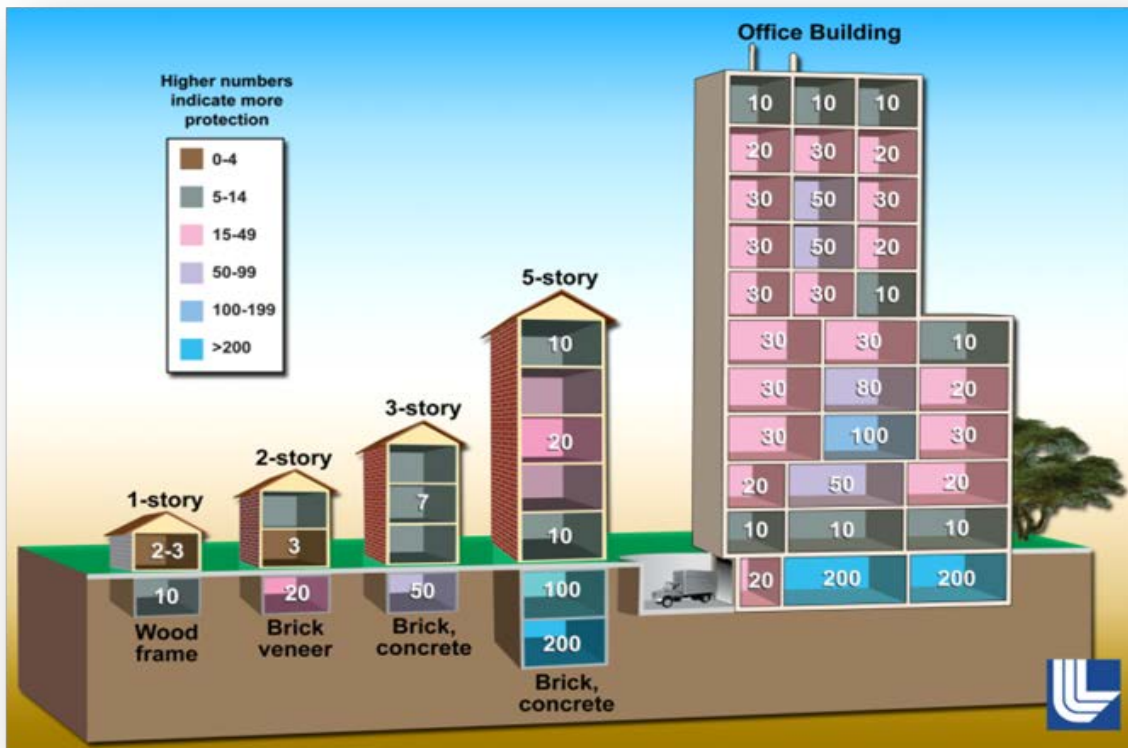
TAKE PROTECTIVE SHELTER IF YOU SEE A NUCLEAR FLASH

Stay down behind shelter for at least two full minutes. Any type of shelter could prevent serious burns and injuries from flying and falling debris such as broken glass. If a nuclear flash causes blindness, it is generally temporary.

GO INSIDE AND STAY INSIDE

- Take shelter immediately:
 - Go to an underground area or basement if possible or stay under a roof near interior walls
 - You should remain inside for 12 to 24 hours after a nuclear emergency—even if you are separated from your family

Figure 11: Shelter quality information that can be distributed to citizens, LLNL



10.0 Appendix D: California Radiological/Nuclear Emergency Response Plan Case Study

10.1 Plan Charter: Cal EMA produced a draft charter for the production of California's RNER in 2012 (3 years prior to an expected completion date of 2015). The RNER Project Charter describes the product/process required in a phased cycle in which milestones are met within a given timeframe.

- **Purpose and Scope:** The RNER plan is expected to strengthen catastrophic emergency management planning. Within this section three scenarios of concern are laid out and explained as the focus of the plan:
 - *Nuclear detonation:* Nuclear weapons include, but are not limited to, weapons obtained from known nuclear nation states, weapons created or improvised by non-state actors.
 - *Radiological release:* radiological weapons will include explosive dispersal devices, mechanical or simple dispersal devices and in situ radiation exposure sources.
 - *Fall-out:* Fall-out is considered when a nuclear detonation occurs, either at the site of the detonation or in other counties or states posing a significant exposure to the public in California.
- **Motivation for the Plan:** Federal modeling suggests that if a 10 kiloton nuclear ground burst detonation occurred in large metropolitan city, having an effective plan, coordinated communications, and a prepared public could result in hundreds of thousands lives saved. This project intends to provide the tools necessary to save the lives by identifying actions needed within minutes, hours, and a sustained period of time after a detonation or radiological release.
- **Goals and Objectives:**
 - Provide a clear understanding of the immediate response needs associated with a radiological or nuclear event.
 - Clearly identify and educate stakeholders on the state and federal authorities for response to a threat or actual radiological or nuclear attack on California.
 - Create a coordinated understanding of the roles, responsibilities and capabilities of state, local, and federal agencies in responding to a radiological or nuclear event.
 - Provide planning and response guidance consistent with SEMS, NIMS, and other federal response guidance.
 - Develop communication protocols to provide immediate notification and response actions for the public concerning the radiological or nuclear event.
 - Provide a basis for identifying needed training of personnel and exercising the capabilities of local, state and federal agencies for responding to a radiological or nuclear event.
 - Coordinate with the California Department of Public Health (CDPH) Nuclear Detonation Aftermath Plan

10.2 Approach

The analytic framework primarily provides a mechanism for data collection and gap analysis that will guide the next steps of plan development.

10.3 Workshop Design

Two stakeholder workshops were designed and conducted in southern and northern California. Cal EMA decided that given the three scenarios they feel are of concern to California (IND, RDD, fallout from a neighboring state) there is a substantial gap in IND response capabilities. Cal EMA designated the IND scenario as the priority for workshop discussions. The design team identified areas of concern to be addressed during the workshops consisting of: managing the response, characterizing the incident and managing shelter-in-place and evacuation planning. Each topic was discussed in two different time phases, the first minutes and hours after a detonation and the first days after a detonation. Within those time frames participants were asked to identify priorities and challenges/gaps related to each topic. Discussion groups were broken up into three self-selected groups: field (first responders), local, and state/federal. For each topic the groups were asked to answer three questions:

1. How would you approach the tasks identified?
2. What do you see as your jurisdictional/profession's priorities?
3. What challenges do you foresee?

The discussion groups were provided reference information illustrated in figure 12 below in order to provide context for the topics of interest.

Figure 12: Reference Sheet and Template for Workshop Group Discussion, CCP 2013

Strategic Priorities

- | | |
|----------------------------------|-------------------------|
| ➤ Early, Adequate Shelter | ➤ Support Public Safety |
| ➤ Protect Response Personnel | ➤ Medical |
| ➤ Support Situational Assessment | |

Key Functions to Address Priorities	Actions	What are the Gaps?
Managing the response <i>Rapidly establish situational awareness of the scope of the event, establish communications and control measures, and coordinate the large number of response assets needed for such an event. As needed, establish priorities and coordination measures.</i>	<ul style="list-style-type: none"> Getting and using Time-Critical Incident Information (modeling and measurements discussed in "Characterizing the Incident" section, this focus is on getting and using information) 	
	<ul style="list-style-type: none"> Support Emergency Public Information Delivery (Note Shelter/Evac message and <u>planning</u> is separate section) 	
	<ul style="list-style-type: none"> Who has the capability to deploy messaging, what are the barriers for rapid deployment 	
	<ul style="list-style-type: none"> Establish Command/Management 	
	<ul style="list-style-type: none"> Establish Emergency Communications 	
	<ul style="list-style-type: none"> Support Safe Worker Entry and Operations 	
	<ul style="list-style-type: none"> Other? 	

Characterizing the Incident <i>Assess impacts; gather info; understand trends.</i>	<ul style="list-style-type: none"> Supporting modeling to make predictions 	
	<ul style="list-style-type: none"> Determine hazards to people 	
	<ul style="list-style-type: none"> Assess damage and other hazards (fires, toxic release, etc..) 	
	<ul style="list-style-type: none"> Characterize/Measure Fallout Radiation in the area 	
	<ul style="list-style-type: none"> Other? 	
Managing shelter-in-place & evacuation planning <i>Given pre-scripted messaging is available, plan for the safe and effective sheltering-in place of an at-risk population; followed by an organized and managed evacuation of the at-risk population to areas of safe refuge.</i>	<ul style="list-style-type: none"> Managing Shelter-in-Place and Evacuation planning 	
	<ul style="list-style-type: none"> Perform Search and Rescue 	
	<ul style="list-style-type: none"> Organize and Manage Evacuation 	
	<ul style="list-style-type: none"> Provide Essential Basic Care 	
	<ul style="list-style-type: none"> Other? 	

10.4 Workshop Findings/ Analytical Framework Summary²¹

The recommendations below are based on the information received from the stakeholder workshops. They are recommendations to Cal EMA to consider as they move to the next phase of the RNER development project.

10.4.1 Communication/Messaging

- A public preparedness campaign should be developed with messaging that is appropriate to the state's diverse population and that provides clearly stated actions to take in the event of an incident.
- Development of "just-in-time education" as part of continuing emergency public information should be considered on a variety of radiation event topics, e.g., instructions for self-decontamination.

10.4.2 Education and Training

- Both the public and responders should be aware of and trained on actions that should be taken in the event of a nuclear event. Any public preparedness campaign should include drills.
- Development or identification of existing information and training should be provided for elected officials and decision-makers who will need to understand the importance of acting promptly and appropriately.
- First responders should be trained about immediate actions they should take in an IND event, e.g., sheltering in place until it is safe to deploy.
- Pre-event education efforts should be provided to first responders and hospitals about treatment of contaminated people.

10.4.3 Planning

- A list of “first ten plays” and “triggers” should be developed to help move information quickly, to make decisions, and to take pre-identified actions.
- Infrastructure repair interdependencies and priorities for restoration should be identified.
- Development of a decision-making process that includes the ability to establish expedient and controversial joint priorities should be considered.
- Specific radiological event models, real-time data input required and methods to analyze and distribute the outcomes should be identified.
- Standard terminology to be used in radiological events should be agreed upon.
- There should be agreement at all levels about release of an initial warning, the content of the warning, and who will be the spokesperson.
- Public shelter facilities should be pre-identified and marked.
- Resolution of conflicting guidance on population exposure monitoring/dose assessment, decontamination, and self-decontamination instructions should be addressed.
- Policies for people contaminated by fallout v. exposed to radiation into shelters should be developed.
- Standards of care/triage specific to a nuclear event need to be defined and approved and training provided.
- Allocation of scarce medical resources, including treatment options, needs to be addressed.
- A large-scale fatality management plan should be developed.

10.4.5 Resources

- Anticipated resource needs should be identified and prioritized pre-event.
- Resource/capability lists and activation/request procedures should be established pre-event.
- Radiation exposure limits for workers should be defined and workers need to be trained on those limits.
- Mutual aid agreements and the Emergency Management Assistance Compact (EMAC) should be reviewed for applicability in a nuclear event.
- The utilization of volunteers and potential assignments should be considered.

10.5 CA Successes

Discovery Phase: Cal EMA designated the initial phase of plan development as a discovery phase. This is an excellent way to characterize the first stage of planning in which the needs of the project and the capabilities and gaps of the response communities are explored. This will also allow the process to be shaped and expanded upon as new requirements are discovered.

The focus of this phase is data collection. Data collection is the most time consuming aspect of the planning process. Conducting the collection of information through a third party as Cal EMA did can have significant benefits when the time comes to actually write the plan. Utilizing a third party for this purpose also allows the information collected to be presented objectively.

Participation of the Scientific Community: Cal EMA recognized the need for sound scientific support in this project. Engaging a national laboratory when attempting to understand the impacts of an IND detonation will assist the planning process from THIRA development through recovery planning. The national laboratories, LLNL in particular, maintain a staff of experts knowledgeable on the issues of a nuclear detonation. The laboratories also possess the technical capabilities to generate community specific scenarios and modeling that will assist responders and planners in understanding the nature of an IND detonation in a specific region.

Workshop Presentations: The Core Planning Team was successful in identifying prominent speakers from several different backgrounds for the workshops. Speakers from the public health, state, local and federal emergency management fields set the stage for the workshop. Including speakers from various fields allowed the stakeholders from those fields to view how the detonation of an IND applied to them. The presentations at the workshop did an excellent job of eliciting several questions and comments regarding the aftermath of an IND detonation.

Public Availability of Analytic Framework: The first product was the analytic framework containing information compiled during the discovery phase intended for public release. The second was a more descriptive analysis of the discovery phase that was designated with an Official Use Only classification. By making at least one of the documents available to the public Cal EMA has taken the first step in public education and broad socialization of the threat.

10.6 Recommendations

Cal EMA has made several steps in the right direction in developing their RNER plan. Based on the information and interactions elicited at the workshops several recommendations are pertinent for communities looking to begin a similar process.

Conducting a THIRA: The research and information needed to support the threat scenario in the THIRA will also support future planning efforts. Representatives from FEMA Region 10 have indicated that research on the likely impacts and consequences of a nuclear detonation are needed for the inclusion of nuclear/radiological terrorism in their THIRAs. Communities like this can leverage the research they perform in support of the THIRA for their future planning efforts to avoid wasting time and energy. The THIRA provides a baseline assessment of the threat and the capabilities needed to address it, by performing this task first, communities can use the knowledge gained during the process as a foundation to build on later.

Time: Time will always be an issue when engaging in an extensive process like planning for nuclear and radiological terrorism. Funding issues also drive the time allotted and can dictate the extent of how developed plans become. Organizations seeking to start the planning process should provide as much time as possible for effective project management and stakeholder collaboration. In the case of a statewide planning effort in particular, time should be a primary consideration. Individuals need to prepare travel arrangements, read any necessary material, and to think about the issue as it pertains to them. Rushing the process eliminates much of this necessary time that will contribute to overall findings.

Planning: Objectives need to be identified before any planning process can begin. Starting to plan without objectives in mind will prove very difficult. Communities need to take a moment at the beginning of their process to first identify their objectives and what they want to achieve with this process. One way to do this is to approach the problem as a discovery phase in the way Cal EMA did. This will give the community an idea of what their stakeholder's objectives and capabilities are and subsequently will influence the type of plan that will be created. Funding may also be an important factor in choosing a planning typology. In most cases disaster planning is less costly than catastrophe planning and will need to be considered when beginning the activity. A clear conception of what the planners want as a final product, should be agreed upon before delving too heavily into the process. It is better to begin the process with a consensus amongst program managers and then expand on objectives as new details emerge rather than begin with a lack of consensus.

Stakeholder Collaboration: It is important to identify roles and responsibilities ahead of time. This may require a group of local, state, and federal officials to meet and devise a strategy prior to interaction with the response community. Observations of the workshops indicate that many agencies are unclear on who will be in charge during and after an event. Though certain roles and responsibilities will need to be identified during the stakeholder workshops, the primary levels of authority should be established sooner. This will allow the workshops to focus more on the available capabilities rather than who is in charge.

Attempt to Elicit Capabilities in addition to Gaps: When discussing an event as overwhelming as a nuclear detonation it is easy for stakeholders to feel as if there are far more gaps than capabilities. Though this may be true, it is more important to identify what each stakeholder can contribute. During stakeholder discussions gaps should be discussed first. Doing so allows members to identify what their needs are based on what they feel they are missing. This discussion will transition well into a capabilities discussion. By identifying the gaps ahead of time members will be forced to think about how to actually address the gaps rather than dwell on them.

One technique for improving the capabilities discussion may be to offer two-day workshops. The first day would serve as a gap analysis, identifying what the stakeholder's felt was missing from their response capabilities. The second day would revolve around addressing the gaps identified during the first day. The two-day workshop structure offers participants the time to think about the first day's discussion and come more prepared for the second day. If participants are given more time to think about the issue it is obvious they will have more time to identify better options for responding to it.

Read ahead material: This recommendation is seemingly obvious but when dealing with a relatively unknown threat like nuclear terrorism workshop participants should be given adequate reading material to explain how the threat is relevant to them. Stakeholders have full time jobs that inhibit them from quickly reading a stack of material for a workshop two weeks away. Therefore read ahead material must be identified far in advance so that it can be distributed earlier.

¹ House of Representatives, 110th Congress, 1st Session. *Making Emergency Supplemental Appropriations for the Fiscal Year Ending September 30, 2007, and for other Purposes*, April 2007.

-
- ² Government Accountability Office. *Statement of Findings for Review of Nuclear Terrorism Response Plans*, 2013.
- ³ Council of State and Territorial Epidemiologists. *The Status of State-level Radiation Emergency Preparedness and Response Capabilities*, 2010.
- ⁴ Government Accountability Office. *Combatting Nuclear Terrorism: Preliminary Observations on Preparedness to Recover from Possible Attacks Using Radiological or Nuclear Materials*, September 2009.
- ⁵ Federation of American Scientists, *Nuclear Weapons Effects*, URL:
<http://www.fas.org/nuke/intro/nuke/effects.htm>
- ⁶ Department of Homeland Security. *Nuclear Attack Fact Sheet*, News & Terrorism Communicating in a Crisis.
- ⁷ *Ibid*
- ⁸ Buddemeier, B.R., Valentine, J.E. *Key Planning Factors: Response to an IND in the National Capital Region*, Lawrence Livermore National Laboratory, November 2011.
- ⁹ Homeland Security Council Interagency Policy Coordination subcommittee for Preparedness and Response to Radiological and Nuclear Threats. *Planning Guidance for Response to a Nuclear Detonation*, January 16, 2009.
- ¹⁰ California Department of Public Health. *CDPH Nuclear Detonation Operational Plan*, November 2012.
- ¹¹ Jackson, Brian A, et. al. *Protecting Emergency Responders: Lessons Learned from Terrorist Attacks*, RAND Corporation, 2002.
- ¹² *Supra*, citation 33.
- ¹³ *Supra*, citation 40.
- ¹⁴ Benjamin, Georges C. *Medical Preparedness and Response to Nuclear Terrorism*, The Bridge V. 40 N. 2, Summer 2010.
- ¹⁵ Tenforde, Thomas S, et. al. *Health Aspects of a Nuclear or Radiological Attack*, The Bridge V. 40 N. 2, Summer 2010.
- ¹⁶ *Supra*, citation 52.
- ¹⁷ *Supra*, citation 9.
- ¹⁸ *Ibid*
- ¹⁹ Department of Homeland Security, FEMA. *Key Planning Factors for the Aftermath of Nuclear Terrorism; Boston Edition*, November 2012, OUO.
- ²⁰ *Ibid*
- ²¹ Center for Collaborative Policy, California State University, Sacramento, Lawrence Livermore National Laboratory. *California Office of Emergency Services: Summary of Research and Stakeholder Input for the Development of California's Statewide Radiological/Nuclear Emergency Response Plan*.